Agilent B2200A
Femto Leakage Switch Mainframe
Agilent B2201A
14ch Low Leakage Switch Mainframe

User's Guide

Agilent Technologies

Notices

Manual Part Number

B2200-90000

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Manufacturer's Name:	Agilent Technologies International sarl
Manufacturer's Address:	Rue de la Gare 29
Supplier's Address:	CH - 1110 Morges Switzerland

Declares under sole responsibility that the product as originally delivered

Product Name:	Femto Leakage Switch Mainframe Femto Leakage Switch Module 14ch Low Leakage Switch Mainframe 14ch Low Leakage Switch Module
Model Number:	Agilent B2200A Agilent B2210A Agilent B2201A Agilent B2211A
Product Options:	This declaration covers all options of the above product(s)

complies with the essential requirements of the following applicable European Directives, and carries the CE marking accordingly:

Low Voltage Directive (73/23/EEC, amended by 93/68/EEC)
EMC Directive (89/336/EEC, amended by 93/68/EEC)

and conforms with the following product standards

EMC	**Standard**	**Limit**
	IEC 61326:2002 / EN 61326:1997 +A1:1998 +A2:2001 +A3:2003	
	CISPR 11:1997 / EN 55011:1998	Group 1 Class A
	IEC61000-4-2:1995 / EN61000-4-2:1995	4 kV CD, 8 kV AD
	IEC 61000-4-3:1995 / EN61000-4-3:1995	3 V/m, 80-1000 MHz
	IEC 61000-4-4:1995 / EN61000-4-4:1995	0.5 kV signal lines, 1 kV power lines
	IEC 61000-4-5:1995 / EN61000-4-5:1995	0.5 kV line-line, 1 kV line-ground
	IEC 61000-4-6:1996 / EN61000-4-6:1996	3 V, 0.15-80 MHz
	IEC 61000-4-11:1994 / EN61000-4-11:1994	1 cycle, 100%
	Canada: ICES-001:1998	
	Australia/New Zealand: AS/NZS 2064.1	
	The product was tested in a typical configuration with Agilent Technologies test systems.	
Safety	IEC 61010-1:2001 / EN 61010-1:2001	
	Canada: CSA C22.2 No. 1010.1:1992, NRTL/C	

Supplementary Information:
This DoC applies to above-listed products placed on the EU market after:

September 26, 2006
Date

川路 利行

Toshiyuki Kawaji

QA Manager
Agilent Technologies

- **Herstellerbescheinigung**

  GEÄUSCHEMISSION

  Lpa < 70 dB

  am Arbeitsplatz

  normaler Betrieb

  nach DIN 45635 T. 19

- **Manufacturer's Declaration**

  ACOUSTIC NOISE EMISSION

  Lpa < 70 dB

  operator position

  normal operation

  per ISO 7779

NOTE

This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme ?Hla norme NMB-001 du Canada.

This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/ electronic product in domestic household waste.

Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as a "Monitoring and Control instrumentation" product.

Do not dispose in domestic household waste.

To return unwanted products, contact your local Agilent office, or see www.agilent.com/environment/product/ for more information.

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual may impair the protections provided by the equipment. In addition, it violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies, Inc. assumes no liability for customer's failure to comply with these requirements.

NOTE

Agilent B2200 complies with INSTALLATION CATEGORY II for mains input and INSTALLATION CATEGORY I for measurement input terminals, and POLLUTION DEGREE 2 defined in IEC 1010-1.

Agilent B2200 is INDOOR USE products.

- *GROUND THE INSTRUMENT*

  This is Safety Class I instrument. To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The power terminal and the power cable must meet International Electrotechnical Commission (IEC) safety standards.

- *DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE*

  Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

- *KEEP AWAY FROM LIVE CIRCUITS*

  Operation personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

- *DO NOT SERVICE OR ADJUST ALONE*

  Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

- *DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT*

  Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Agilent Technologies Sales and Service Office for services and repair to ensure that safety features are maintained.

- *DANGEROUS PROCEDURE WARNINGS*

  Warnings, such as example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING **Dangerous Voltage, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.**

Safety Symbols

The general definitions of safety symbols used on equipment or in manuals are listed below.

Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage and potential for electrical shock. Do not touch terminals that have this symbol when insrument is on.

Affixed to product containing static sensitive devices--use anti-static handling procedures to prevent electrostatic discharge damage to component.

Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Indicates earth (ground) terminal.

Alternating current.

Direct current.

ON (Supply).

OFF (Supply).

STANDBY (Supply).

CAT 1

Means INSTALLATION CATEGORY I. Measurement terminals on the rear panel comply with INSTALLATION CATEGORY I.

WARNING

The warning sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personal.

CAUTION

The caution sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

In This Manual

This manual is a user's guide for Agilent B2200A/B2201A Switch Mainframe, and consists of the following chapters:

- Introduction

  Describes an overview and specifications of the Agilent B2200 series.

- Installation

  Describes how to install the Agilent B2200 and how to setup the input/output.

- Front Panel Operation

  Explains the front panel operation and the switch control functions of the Agilent B2200, also provides the reference information of the front panel keys and display.

- Programming

  Explains the programming examples that control the Agilent B2200.

- SCPI Command Reference

  Describes the all commands of the Agilent B2200 SCPI commands.

- VXI*plug&play* Driver

  Describes the all functions of the Agilent B2200 VXI*plug&play* driver.

- Error Messages

  Lists and describes the error messages for the Agilent B2200.

Text Conventions

The following text conventions are used in this manual:

`Screen Text`	Represents text that appears on screen of the controller.
Italic	Refers to a related document, or is used for emphasis.

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1 Introduction

This chapter describes the basic functions and features of the Agilent B2200A/B2201A (Agilent B2200 series), and consists of the following sections:

- “Agilent B2200 Series”
- “Front Panel”
- “Rear Panel”
- “Switch Modules”
- “Specifications”
- “Accessories and Options”

Agilent B2200 Series

Agilent B2200 series is a switching matrix designed for semiconductor dc characteristics measurement applications. The Agilent B2200 series has 14 input ports and four card slots for the switch modules (plug-in cards), and can configure a 12, 24, 36, or 48 outputs switching matrix. The Agilent B2200A/B2201A supports the following dedicated switch module.

- Agilent B2210A fA Leakage Switch Module

  Dedicated for the Agilent B2200A mainframe.

- Agilent B2211A 14ch Low Leakage Switch Module

  Dedicated for the Agilent B2201A mainframe.

NOTE Mixed configuration of the switch modules is not supported.

Basic functions of the Agilent B2200 series are listed below.

- SMU inputs (for source monitor units): 8 ports
- AUX inputs (multipurpose inputs): 6 ports
- Outputs: 12, 24, 36, or 48 ports
- Connection setup and status monitor on the front panel
- Status display on the LED matrix display
- Connection setup by the Light pen
- Automatic control through GPIB interface
- Auto ground function
- Self-test, relay function test
- Relay cleaning

Front Panel

The Agilent B2200 series provides the front panel keys, the LCD, and the LED matrix display for the status monitor and connection setup.

- Line switch

  Used to turn the Agilent B2200 on or off.

- LCD

  Used to monitor the status and set the connection. See Chapter 3 for the details.

- Front panel keys

  Used to set the Agilent B2200. See Chapter 3 for the details.

- LED matrix display

  Displays the status of the matrix switches. Also used to set the matrix connection with the light pen.

- SMU Input

  Inputs for the source monitor unit (SMU). Eight input ports. Up to four kelvin inputs are available. Triaxial BNC connector.

- AUX Input

  Multipurpose inputs. Six input ports. Coaxial BNC connector. CMH and CML terminals are the input ports for the capacitance measurement.

  The input port 12 (AUX Input 12) is the default ground input port. If you assign the port as the ground input port, this ground port will be internally connected to the ground when the ground mode is set to ON. In this case, open this connector.

- Light Pen

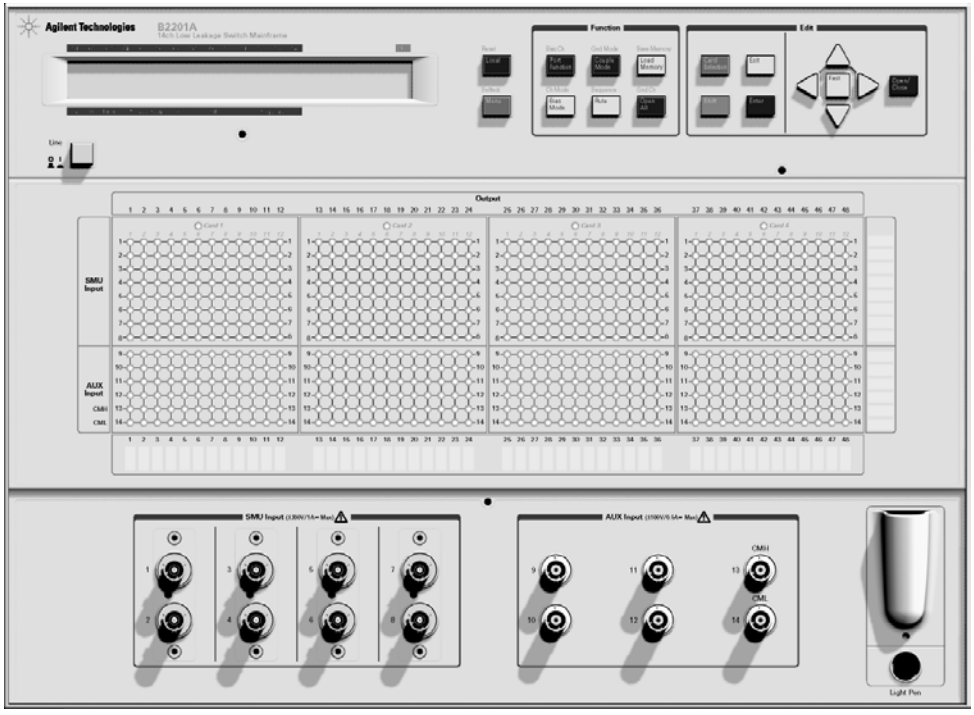
  Connector for the Agilent 16443A Light pen. Used to set the matrix connection with the LED matrix display.

CAUTION

For the SMU Input terminals, the maximum measurement voltage/current/voltage between terminals are ±200 V/1 A/300 V, respectively. And for the AUX Input terminals, they are ±100 V/0.5 A/100 V.

Do not apply an input signal over these limits to the input terminals. If you do, the Agilent B2200 will be damaged. If you use a bias source that has current limit capability, set the bias source current limit.

Figure 1-1 Front Panel View



Rear Panel

The Agilent B2200 series has four card slots for the switch modules, the GPIB interface and so on.

- Card slots

  For the Agilent B2200A mainframe, the Agilent B2210A cards are installed.

  For the Agilent B2201A mainframe, the Agilent B2211A cards are installed.

  Mixed configuration of the switch modules is not supported.

- GPIB interface

  Use an Agilent 82357A USB/GPIB interface or Agilent 10833A/B/C/D GPIB cable to connect to an external computer or equipment.

- Serial number

  You need this serial number when using the Agilent Technologies telephone assistance program.

- LINE input receptacle

  AC power cable is connected to this receptacle.

Figure 1-2 Rear Panel View

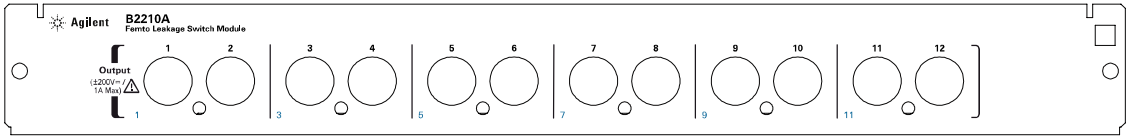
Switch Modules

The Agilent B2200A and B2201A support the dedicated switch module, Agilent B2210A and B2211A, respectively.

By installing the modules, the module inputs will be connected internally to the front panel input connectors. And 12 output connectors will face the rear panel. The type of the output connectors is the triaxial BNC. Up to six kelvin outputs are available.

Image of the output terminals and the block diagram of the switch module are shown in Figure 1-3 and Figure 1-4.

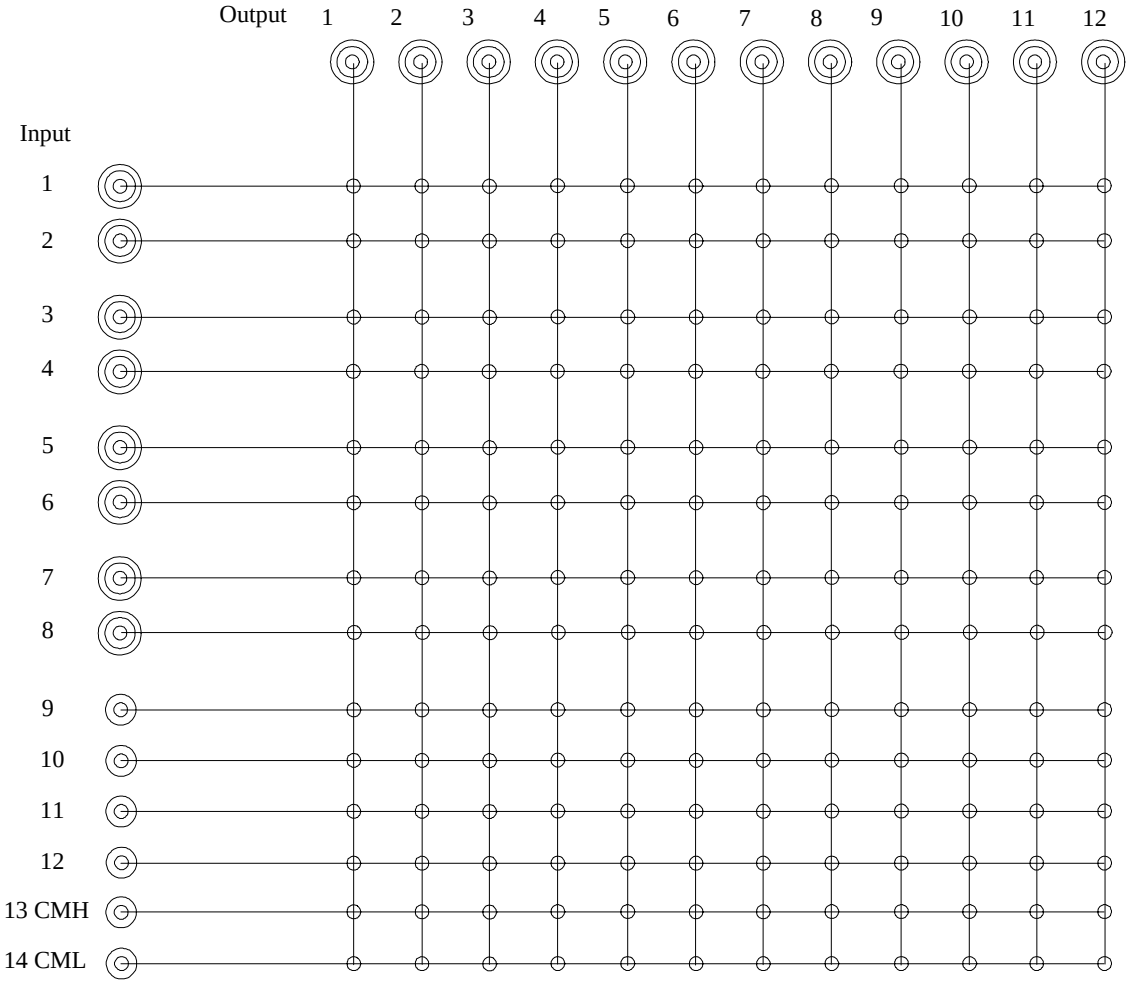
Figure 1-3 Switch Module Output Terminals



WARNING **Do not touch the force and guard terminals of the output connectors while the Agilent B2200 is turned on. Dangerous voltages up to the maximum input voltage may be present at the output connectors.**

NOTE Mixed configuration of the switch modules is not supported.

Figure 1-4 Switch Module Block Diagram



Specifications

This section lists specifications and supplemental information for the Agilent B2200 series.

- “General Specifications”
- “Switch Modules”
- “Supplemental Information for B2200A/B2210A”
- “Supplemental Information for B2201A/B2211A”

The specifications are the performance standards or limits against which these units have been tested. The supplemental information is not warranted, but provides useful information about functions and performance.

If not noted otherwise, the conditions for specifications and supplemental information are as follows:

Temperature: 23 °C ± 5 °C

Humidity: 5 % to 60 % R.H.

General Specifications

Temperature range:	Operating: 5 °C to 35 °C Storage: – 20 °C to 70 °C
Humidity range:	Operating: 5 % to 70 % R.H., non-condensing Storage: < 80 % R.H. at 35 °C, < 60 % R.H. at 65 °C, non-condensing (B2200A/B2210A) < 80 % R.H. at 65 °C, non-condensing (B2201A/B2211A)
Altitude:	Operating: 0 to 2,000 m (6,500 ft) Storage: 0 to 15,240 m (50,000 ft)
Regulatory compliance:	Safety: CSA C22.2 No. 1010.1/IEC 1010-1 EMC: CISPR 11 Group 1 class A&EN50082-1
Power requirement:	90 to 264 V (continuous), 47 to 63 Hz, 2 A/200 VA maximum
Number of slots:	4 slots for 48 mm height switch module
Dimensions:	B2200A/B2201A: 430 mm W × 320 mm H × 600 mm D B2210A/B2211A: 395 mm W × 48 mm H × 500 mm D
Weight:	B2200A/B2201A: approximately 14.0 kg B2210A: approximately 5.0 kg B2211A: approximately 3.5 kg
Number of ports:	SMU input: 8 triaxial ports (with Guard) AUX input: 6 coaxial ports (two ports for capacitance measurement) Output: 12 triaxial ports (with Guard), maximum 48 ports

Switch Modules

Table 1-1 lists the specifications when the switch module is installed in the mainframe. In the table, the conditions are as follows:

Conditions: 23 °C ± 5 °C, 5 % to 60 % R.H.

Table 1-1 **Agilent B2210A/B2211A Switch Module Specifications**

	B2210A	B2211A
Max. current rating (A)		
SMU input	1.0	1.0
AUX input	0.5	0.5
Max. voltage rating (V)		
SMU input, channel to common	200	200
SMU input, channel to channel	300	300
AUX input, channel to common	100	100
AUX input, channel to channel	100	100
Closed channel residual resistance (Ω)		
SMU input	0.6	0.6
AUX input	1.5	1.5
Channel isolation resistance (Ω)		
SMU input	10^{14}	5×10^{13}
AUX input	10^{9}	10^{9}

The Agilent B2200A mainframe supports the Agilent B2210A module.

The Agilent B2201A mainframe supports the Agilent B2211A module.

Mixed configuration of the switch modules is not supported.

Supplemental Information for B2200A/B2210A

Offset current [1]	< 10 fA (typical 3 fA) (SMU input)
IM noise (RMS) [2]	0.6 fA (SMU input)
Channel crosstalk capacitance	< 1 pF/channel (SMU input)
	< 3 pF/channel (AUX input)
Offset voltage	< 50 μV (SMU input)
	< 80 μV (AUX input)
Settling time [3]	2.0 seconds
Bandwidth (at -3dB)	30 MHz (SMU input)
Guard capacitance [4]	< 145 pF (SMU input)
Additional C measurement error [5]	< ± 1 % + 0.2 pF (SMU input)

1. When the voltage applied to all input-output channels is 0 V.
2. Measured by the Agilent 4156C with the integration time setting 100 PLC. When the voltage applied to all other input-output paths is 0 V.
3. The time until the measurement value settles to within 50 fA of the final value. When the applied voltage is 10 V.
4. When four modules have been installed in the mainframe. And when only one input-output path is made.
5. For the measurement less than 1000 pF at the frequency 1 kHz to 1 MHz, using the Agilent 4284A with 3 m cable. After the compensation using the capacitance compensation algorithm (a function of VXI*plug&play* driver).

Supplemental Information for B2201A/B2211A

Offset current [1]	< 50 fA (SMU input)
IM noise (RMS) [2]	5 fA (SMU input)
Channel crosstalk capacitance	< 0.5 pF/channel (SMU input)
	< 3 pF/channel (AUX input)
Offset voltage	< 80 μV (SMU input)
	< 100 μV (AUX input)
Settling time [3]	2.0 seconds
Bandwidth (at -3dB)	30 MHz (SMU input)
Guard capacitance [4]	< 145 pF (SMU input)
Additional C measurement error [5]	< ± 1 % + 0.2 pF (SMU input)

1. When the voltage applied to all input-output paths is 0 V.
2. Measured by the Agilent 4156C with the integration time setting 100 PLC. When the voltage applied to all other input-output paths is 0 V.
3. The time until the measurement value settles to within 300 fA of the final value. When the applied voltage is 10 V.
4. When four modules have been installed in the mainframe. And when only one input-output path is made.
5. For the measurement less than 1000 pF at the frequency 1 kHz to 1 MHz, using the Agilent 4284A with 3 m cable. After the compensation using the capacitance compensation algorithm (a function of VXI*plug&play* driver).

Accessories and Options

Agilent B2200 is furnished with the following accessories.

- Power cable, 1 ea.
- Operation summary sheet, 1 ea.
- Manual CD-ROM, 1 ea.
- Software CD-ROM, 1 ea.

  Stores the Agilent B2200 VXI*plug&play* driver.

  The Agilent B2200 VXI*plug&play* driver supports Windows XP Professional, Windows 2000, Windows NT 4.0, Windows 98, and Windows 95.
- Moisture-proof and dehumidifying packing kit, 1 set

Table 1-2 lists the options and accessories available for the Agilent B2200.

Table 1-2 Options and Accessories

Model Number	Option Item	Description
B2200A		fA Leakage Switch Mainframe
	B2200A-UK6	Commercial cal. certificate w/ test data
	B2200A-ABA	Manual set, English
	B2200A-ABJ	Manual set, Japanese
B2201A		14ch Low Leakage Switch Mainframe
	B2201A-UK6	Commercial cal. certificate w/ test data
	B2201A-ABA	Manual set, English
	B2201A-ABJ	Manual set, Japanese
B2210A		fA Leakage Switch Module (for B2200A)
B2211A		14ch Low Leakage Switch Module (for B2201A)
16443A		Light pen
16493H		GNDU cable (between 41501/4142 and 16495F/G)
	16493H-001	1.5 m length
	16493H-002	3 m length
16493J		Interlock cable (between E5260/E5270/4155/4156 and 16495F/G)
	16493J-001	1.5 m length
	16493J-002	3 m length
	16493J-003	5 m length
16493K		Kelvin triaxial cable (between B2200 inputs and E5260/E5270/4156/41501)
	16493K-001	1.5 m length
	16493K-002	3 m length
16493L		GNDU cable (between E5260/E5270 and 16495F/G)
	16493L-001	1.5 m length
	16493L-002	3 m length
	16493L-003	5 m length
16493N		GNDU cable for Kelvin connection (between B2200 inputs and E5260/E5270/41501/4142)

Model Number	Option Item	Description
16494A		Triaxial cable
	16494A-001	1.5 m length
	16494A-002	3 m length
	16494A-003	80 cm length
	16494A-005	4 m length
16494B		Kelvin triaxial cable (between B2200 inputs and 4142B, between B2210/B2211 outputs and 16495F/G)
	16494B-001	1.5 m length
	16494B-002	3 m length
	16494B-003	80 cm length
16494C		Kelvin triaxial cable (between B2210/B2211 outputs and B2220A)
	16494C-001	1.5 m length
	16494C-002	3 m length
	16494C-005	4 m length
16494F		CMU Input cable, 2 m (between B2200 CMH/CML and 4-terminal pairs connectors)
16495E		Half size blank plate
16495F		Half size connector plate with 12×triaxial, intlk, GNDU
	16495F-001	Bulkhead feedthrough connectors (female to female)
	16495F-002	Connectors to contacts for soldering
16495G		Full size connector plate with 24×triaxial, intlk, GNDU
	16495G-001	Bulkhead feedthrough connectors (female to female)
	16495G-002	Connectors to contacts for soldering

2 Installation

This chapter describes requirements to install Agilent B2200 and the tasks for installation, and is organized into the following three sections:

- “Requirements”
- “Inspection”
- “Installing the B2200”
- “Self-Test”
- “Output Connections”
- “Input Connections”
- “Measurement Cable Length”
- “Maintenance”

WARNING

The maximum input voltage of the Agilent B2200 is ±200 V. And dangerous voltages may be present at the output terminals. To prevent electric shock, you must observe the following safety precautions when using the Agilent B2200.

- **Use a three-conductor ac power cable to connect cabinet (if used) and the Agilent B2200 to an electric ground (safety ground).**
- **If you need to touch the force and guard terminals of the output connector, turn off the Agilent B2200 and discharge any capacitors whenever possible.**
- **Warn workers around the B2200 about dangerous conditions.**

Requirements

This section describes the following requirements for the Agilent B2200.

- “Power Requirements”
- “Power Cable”
- “Operating Environment”
- “Storage and Shipping Environment”

Power Requirements

CAUTION Before applying ac line power to the Agilent B2200, ensure that the correct power cable is used.

The Agilent B2200 can operate from any single-phase ac power source supplying 90 to 264 V in the frequency range from 47 to 63 Hz. The maximum power consumption is 2 A/200 VA.

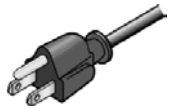
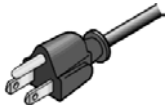
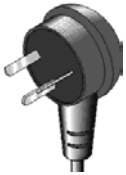
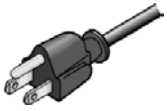
Power Cable

In accordance with international safety standards, this instrument is equipped with a three-wire power cable. When connected to an appropriate ac power outlet, this cable grounds the instrument frame. The type of power cable shipped with each instrument depends on the country of destination. See the following table for the part numbers of the power cables available.

If the plug on the cable does not fit the power outlet, or the cable is to be attached to a terminal block, cut the cable at the plug end and re-wire it. This work should be performed by a qualified electrician all local electrical codes being strictly observed.

The color coding used in the cable will depend on the cable supplied. If a new plug is to be connected, it must meet local safety requirements and include the following features:

- Adequate load-carrying capacity.
- Ground connection.
- Cable clamp.

 • Plug: BS 1363/A, 250 V, 10 A • Cable: 8120-4420, 8120-1351	 • Plug: AS 3112, 250 V, 10 A • Cable: 8120-4419, 8120-1369	 • Plug: CEE 7 sheet VII, 250 V, 10 A • Cable: 8120-4519, 8120-1689	 • Plug: NEMA 5-15P, 125 V, 10 A • Cable: 8120-6825, 8120-1378, 8120-1395
 • Plug: NEMA 6-15P, 250 V, 10 A • Cable: 8120-3996, 8120-0698	 • Plug: SEV 1011, 250 V, 10 A • Cable: 8120-2104	 • Plug: SR 107-2-D1, 250 V, 10 A • Cable: 8120-2956	 • Plug: IS 1293 and IS 6538, 250 V, 10 A • Cable: 8121-1582, 8120-4211
 • Plug: JIS C 8303, 125 V, 12 A • Cable: 8121-0743, 8120-4753	 • Plug: Israel SI 32, 250 V, 10 A • Cable: 8120-5182	 • Plug: IRAM 2073-10A, 250 V, 10 A • Cable: 8120-6870	 • Plug: CEI 23-16, 250 V, 10 A • Cable: 8120-6978
 • Plug: GB 1002 figure 3 , 250 V, 10 A • Cable: 8120-8376	 • Plug: SANS 164-1, 250 V, 10 A • Cable: 8121-0564, 8120-4211	 • Plug: CNS 10917-2, 125 V, 10 A • Cable: 8121-1635, 8120-6825	 • Plug: CS 0017:2003, 250 V, 10 A • Cable: 8120-8871, 8120-0674, 8121-1638

WARNING **For protection from electrical shock, the power cable ground must not be defeated.**

Operating Environment

The Agilent B2200 must be operated within the following environmental conditions:

- Temperature: 5 °C to 35 °C
- Humidity: 5 % to 70 % R.H., non-condensing
- Altitude: 0 m to 2,000 m

Storage and Shipping Environment

The Agilent B2200 should be stored or shipped in environments within the following limits:

- Temperature: -20 °C to 70 °C
- Humidity:

  B2200A/B2210A:
  < 80 % R.H. (at 35 °C), < 60 % R.H. (at 65 °C), non-condensing

  B2201A/B2211A:
  < 80 % R.H. (at 65 °C), non-condensing
- Altitude: 0 m to 15,240 m

CAUTION When storing the Agilent B2200

Protect the Agilent B2200 from temperature extremes to prevent condensation from forming inside the Agilent B2200. If condensation occurs, the Agilent B2200 may damage or may not satisfy the specifications. If the Agilent B2200 was placed at the high temperature and high humidity environment long time, the Agilent B2200 may degrade its performance.

NOTE When shipping the Agilent B2200

The Agilent B2200 must be packed in the certain packing materials for protection from damage when it is shipped. Cover the Agilent B2200 by using the moisture-proof and dehumidifying packing material (furnished), and pack it by using packing materials such as carton box and cushioning materials.

Inspection

CAUTION

Before Opening Packing Materials

The Agilent B2200 contains the condensation sensitive electronic parts. The condensation will have a negative impact on the Agilent B2200 to operate normally.

Do not open the packing materials, and leave the Agilent B2200 to acclimate it to the installation environment (temperature and humidity). If it is opened without enough acclimation, the Agilent B2200 may damage.

When you open the box that contains the Agilent B2200, check the following:

1. Before unpacking any components, inspect all boxes for any signs of damage that might have occurred during shipment such as:
   - Dents
   - Scratches
   - Cuts
   - Water marks
2. When you open the boxes that contain the Agilent B2200, check the components against the contents lists that are attached to the boxes.

If anything is wrong, notify your local Agilent Technologies sales office.

Installing the B2200

This section describes how to install the Agilent B2200.

1. See “Requirements” on page 2-3, and determine the installation location.
2. Unpack the Agilent B2200 and place it at the installation site.
3. Plug the power cable into the Line input receptacle at the rear panel.
4. Plug the power cable into the power receptacle.
5. Perform the self-test. See “Self-Test” on page 2-10.
6. If you control the Agilent B2200 by using an external computer:

   Set the GPIB address. See “To Set the GPIB Address” on page 2-8 and “To Connect the GPIB Cable” on page 2-8.
7. If you have to add or replace the switch module:

   Turn the Agilent B2200 off, remove the power cable, and install the switch module. See “To Install the Switch Module” on page 2-9 and “To Install the Blank Panel” on page 2-9.

NOTE

Plug-in module is shipped from the factory after the specifications are confirmed. Agilent can guarantee that the modules will function and that the module performance is designed to meet its specifications. However, if you have any trouble, contact your nearest Agilent Technologies service center.

If you require that the modules be guaranteed to their specifications (for ISO compliance, etc.), then you must perform a calibration on the instrument (modules and mainframe together). For calibration, contact your nearest Agilent Technologies service center.

To Set the GPIB Address

Every device on the GPIB bus must have a unique address. If you need to change the GPIB address, turn the Agilent B2200 on and perform the following procedure. The new GPIB address is recognized only at power on. The Agilent B2200 leaves the factory with the GPIB address set to 22.

1. Press the **Menu** key.
2. Move the cursor to CONFIG, then press the **Enter** key.
3. Move the cursor to ADDRESS, then press the **Enter** key. The following message will appear on the LCD. *XX* will be 0 to 30.

   GPIB Address = *XX*
4. Press the arrow key (up or down) to specify the desired GPIB address, then press the **Enter** key.
5. Press the **Enter** key twice.
6. Turn the Agilent B2200 off, and then turn it on again.

To Connect the GPIB Cable

To connect the instrument with a computer or peripheral device via GPIB (IEEE Std. 488), connect an GPIB cable between the GPIB connector on the instrument rear panel and the GPIB connector on the peripheral device.

Including the controller, a total of 15 *GPIB interfaces* can be connected on the same GPIB bus. The following are rules for connecting GPIB interfaces:

- If total number of interfaces ≤ 10:

  Max. total cable length = number of interfaces × 2 m.
- If total number of interfaces > 10:

  Max. total cable length = 20 m.
- Maximum cable length between interfaces is 4 m.
- Star connection and cascade connection are allowed. Loop connection is *not* allowed.

To Install the Switch Module

WARNING ⚠ **To prevent electrical shock, turn off the mainframe and remove the power cable before starting the instruction.**

CAUTION Be careful about the module pins used for internal connection to the Agilent B2200. The pins can be damaged easily.

Use clean handling and anti-static procedures when removing, configuring, and installing the switch modules. The modules contain components that can be damaged by static electricity.

The following procedure explains the module installation and removal.

1. Turn off the Agilent B2200, then wait at least 10 seconds before you remove or install a module.
2. Loosen the screws on both the left and right edges of a blank panel or a module attached to the slot you want to install a new module.
3. Remove the blank panel or the module.
4. Align the new module with the left and right slot guide rails. Then the component side should be facing up.
5. Push the module into the slot until you feel it seat firmly into the connector at the back of the slot.
6. Screw in the screws on the left and right edges of the module.
7. Execute the self-test and the relay test. See “Self-Test” on page 2-10.

To Install the Blank Panel

CAUTION To prevent thermal damage to the module, be sure that blank panels are installed in all unused slots.

If the blank panel is not installed to cover an unused slot, install the blank panel as follows:

1. Align the blank panel over the unused slot.
2. Screw in the screws on the left and right edges of the blank panel.

Self-Test

NOTE

To confirm the specifications

The self-test and diagnostics checks the operation of the mainframe and the modules. However they cannot confirm if the Agilent B2200 satisfies its specifications.

For verifying the specifications, contact your nearest Agilent Technologies Service Center. Trained service personnel will perform calibration (performance verification).

It is recommended to perform calibration once a year at least.

The following procedure performs the self-test and diagnostics.

1. Turn on the Agilent B2200.

   The controller test will be performed. If the Agilent B2200 fails the test, contact your nearest Agilent Technologies Service Center.

2. Press the **Shift** key and the **Menu** key in this order. Self-test menu will appear on the LCD.

SELF_TEST	Controller test
RELAY_TEST	Relay test
KEY	Front panel interface test
BEEPER	Beeper test
LED	LED matrix test
PEN	Light pen test
GPIB	GPIB test

3. Move the cursor to the test item to perform, then press **Enter** key.

4. To start the test, move the cursor to EXECUTE, then press **Enter** key.

   To display the previous test result, move the cursor to RESULT, then press **Enter** key.

   For the details of each test, see “Selftest Menu” on page 3-34.

Output Connections

This section describes how to connect the Agilent B2200 outputs to prober, connector plate, test fixture, and so on (DUT interface).

- "Output Connectors"
- "Connector Plates"
- "To Make Connections to DUT Interface"
- "To Make Interlock Circuit"
- "To Mount Connectors"

NOTE

Output Connections

If you do not use the connector plate for the connection between the output and the DUT interface, see "To Mount Connectors" on page 2-18.

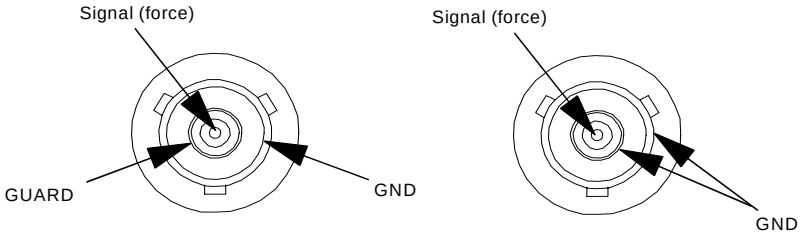
WARNING

Turn off the Agilent B2200 and all instruments connected. And do not turn them on until the connection described in this section is completed. If you ignore this warning, you may be exposed to dangerous voltage.

Output Connectors

The Agilent B2200 output connectors are the triaxial BNC connector. The input signals appears at the output as shown in Figure 2-1 when input-output switching path is made. Figure 2-1 shows signals appear on the output connectors with non-Kelvin connection. If you make Kelvin connection, the signal of the even output connectors is Sense, not Force.

Figure 2-1 **Output Connector and Output Signal**



(a) When SMU is connected (b) When AUX is connected

Connector Plates

Connector plates (Table 2-2) are used for the connection between the Agilent B2200 outputs and the DUT interface (prober and so on). To connect to the connector plate, use the cable shown in Table 2-3.

Table 2-2 Connector Plate

Agilent Model No.	Description
16495F	Half size connector plate 16495F-001 has 12 triaxial through connectors (female to female), an Intlk connector, and a GNDU connector (triaxial through, female to female). The back of the Intlk connector is designed for soldering. 16495F-002 has 12 triaxial connectors, an Intlk connector, and a GNDU connector. The back of each connector is designed for soldering.
16495G	Full size connector plate 16495G-001 has 24 triaxial through connectors (female to female), an Intlk connector, and a GNDU connector (triaxial through, female to female). The back of the Intlk connector is designed for soldering. 16495G-002 has 24 triaxial connectors, an Intlk connector, and a GNDU connector. The back of each connector is designed for soldering.
16495E	Blank plate This plate is used to cover openings when you made too big openings for mounting the connector plate. You will use this plate to cover openings if you mount the half size connector plate in openings made for the full size connector plate.

Table 2-3 Output Cable

Agilent Model No.	Description
16494A	Triaxial cable (for non-Kelvin connection)
16494B	Kelvin Triaxial cable (for Kelvin connection)

NOTE

Installing Connector Plate

To install the connector plate, refer to Agilent 16495 *Installation Guide*.

For Kelvin connection, use Kelvin triaxial cable listed in Table 2-3. To make a Kelvin output port (1, 3, 5, 7, 9 and 11), couple two E5252A output ports as follows:

Kelvin Output Port	Output Port Number
1	1 (Force) and 2 (Sense)
3	3 (Force) and 4 (Sense)
5	5 (Force) and 6 (Sense)
7	7 (Force) and 8 (Sense)
9	9 (Force) and 10 (Sense)
11	11 (Force) and 12 (Sense)

To Make Connections to DUT Interface

This section describes for the connections between the DUT interface and the connectors connected to the Agilent B2200 output cables. See Table 2-4.

NOTE

Low-Noise Coaxial Cable

For the extended measurement paths over the connector plate, use low-noise coaxial cable (Agilent part number 8121-1191). This cable can maximize the guard effects and minimize the impression of the external noise.

Figure 2-2 shows the cutting example of this cable. Key point is the isolation between the conductive layer and the center conductor. So, cut and trim the end of the cable as shown in this figure by using a cutter and so on.

Figure 2-2 **Coaxial Cable Cutting Example**

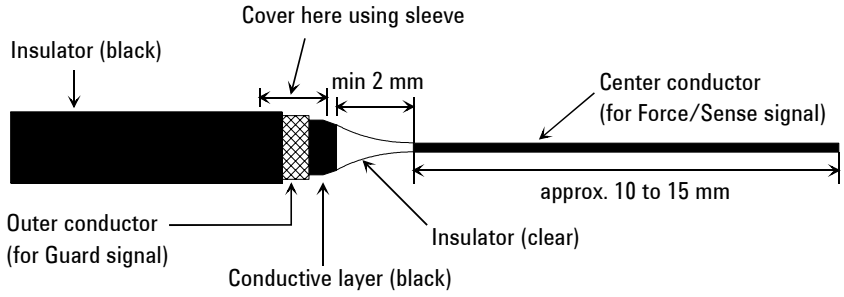
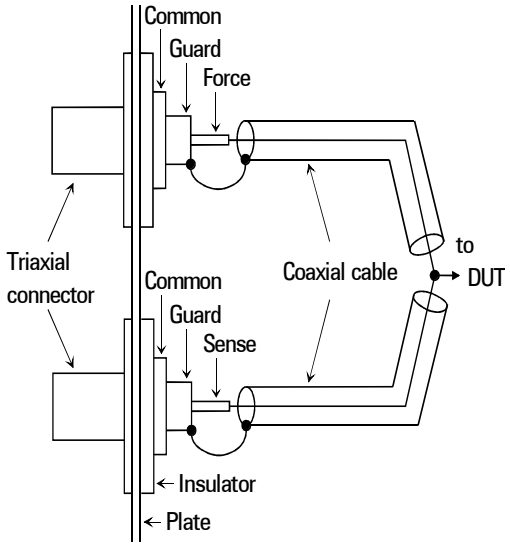
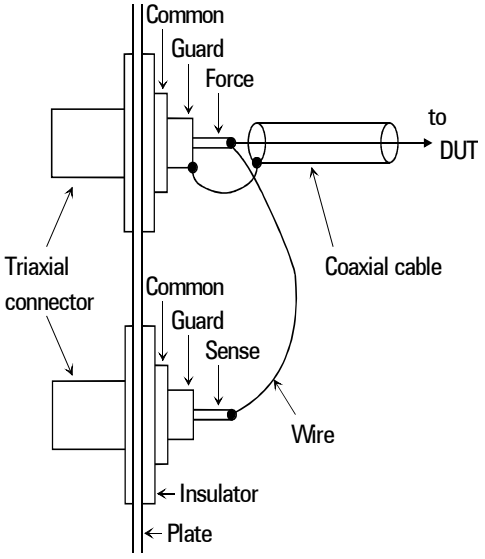


Table 2-4 Connection to the DUT Interface

Kelvin connections	non-Kelvin connections
This connection is available only for the Kelvin connectors. This connection can cancel effects of cable resistance by connect sense line and force line as close as possible to DUT terminal.	Following connection is for the Kelvin connectors. For the triaxial connectors, ignore SENSE terminal, and make connection only for FORCE terminal. Measurement data will include residual resistance from the connection cable.
	

CAUTION Never connect the guard terminal to any output, including circuit common, chassis ground, or the guard terminal of any other unit. Doing so may result in an emergency condition.

For highly accurate current forcing and measurements while minimizing leakage, surround all force and sense lines from SMU by a guard as far as possible, and make cables stable by taping.

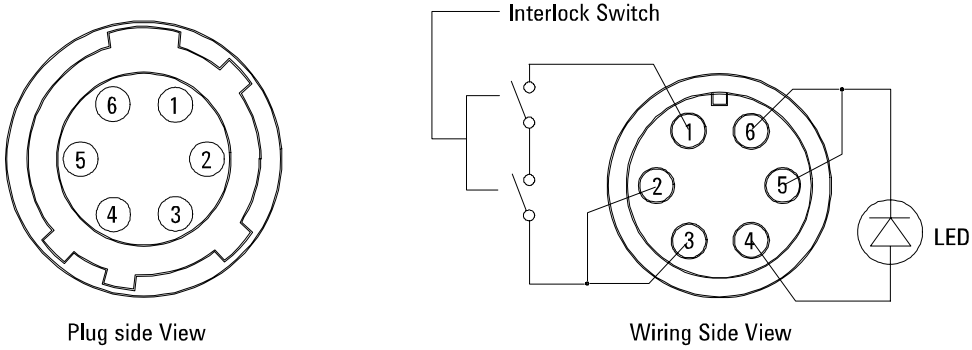
For reducing capacitance measurement error, tape the cables to any grounded materials such as shielding box. If you use probe card, grounding the probe card also reduces capacitance measurement error.

To Make Interlock Circuit

The interlock circuit is to prevent electric shock when touching measurement terminals. You must install an interlock circuit on shielding box to prevent dangerous voltages when door of the shielding box is open.

Figure 2-3 shows the pin assignments of the interlock connector.

Figure 2-3 **Interlock Connector Pin Assignments**



WARNING **Dangerous voltages of up to the maximum voltage of SMUs may be present at force, guard, and sense terminals when the interlock terminals are shorted.**

To Install Interlock Circuit

Install the interlock circuit as follows.

1. Mount two mechanical switches on your shielding box, so that the switches close when the door of the shielding box is closed, and open when the door is opened. For the recommended parts and the dimensions of the switch, see Figure 2-4 and Figure 2-5.
2. Use wire to connect the two switches in series between pin number 1 and 2 (or 3) of the interlock connector. See Figure 2-3.

For example, Agilent 4155/4156 is connected to the interlock circuit, it cannot force more than ±40 V when the door is open. When door is closed, it can force more than ±40 V.

Figure 2-4 **Dimensions of Interlock Switch (Agilent part number 3101-0302)**

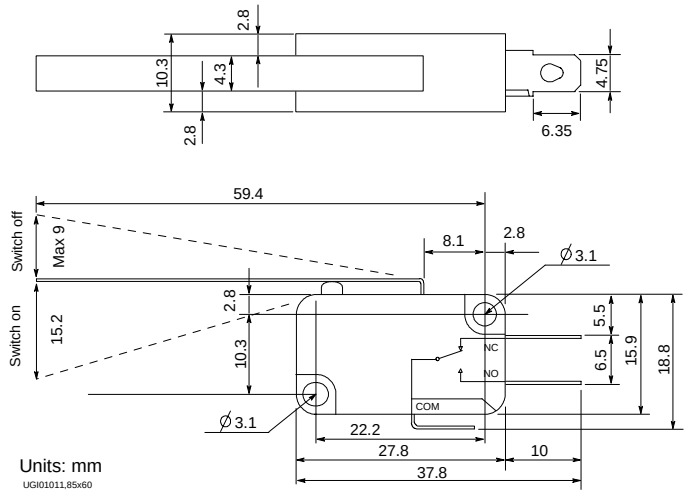
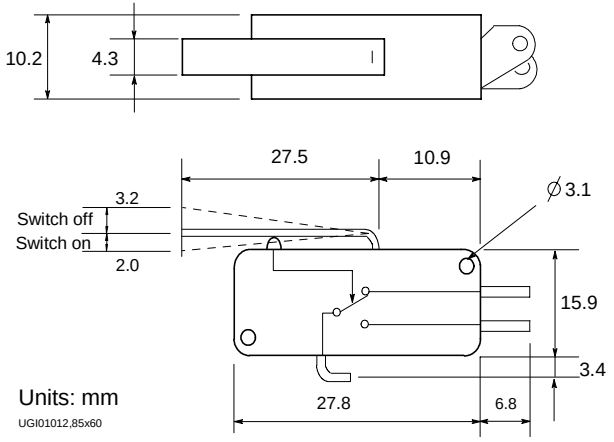


Figure 2-5 **Dimensions of Interlock Switch (Agilent part number 3101-3241)**



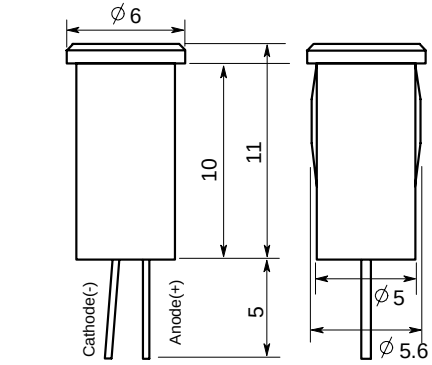
To Install LED Circuit

To install LED circuit on your shielding box, do following:

1. Mount LED on your shielding box. For the recommended parts and the dimensions of the LED, see Figure 2-6.
2. Use wire to connect the LED between pin 4 and pin 5 (or 6) of the interlock connector. See Figure 2-3.

The 4155/4156 semiconductor parameter analyzer's Intlk connector provides the interlock signal and a LED drive signal. If a LED is connected between pin 4 and pin 5 (or 6) of the interlock connector, the LED lights to indicate *high voltage output* when more than ±40 V is forced from an SMU in the 4155/4156.

Figure 2-6 **Dimensions of LED (Agilent part number 1450-0641)**



Units: mm

To Connect Interlock Circuit to Instrument

Before beginning the measurement, connect the interlock circuit to the instrument's interlock connector as follows.

- For the instruments which has a BNC-Type interlock connector:

  1. Get the following parts.
     - Agilent 16493J Interlock cable, 1 ea.
     - Agilent 16435A Interlock cable adapter, 1 ea.
  2. Connect the 16493J interlock cable between the interlock circuit and the 16435A adapter.
  3. Connect the BNC cable (furnished with the adapter) between the adapter and the instrument's interlock connector.

- For Agilent 4155/4156/E5260/E5270:

  Connect the 16493J interlock cable between the interlock circuit and the instrument's interlock connector. You can connect it directly without using any adapter.

NOTE

To Check Interlock Circuit

If you use the 4155/4156, you can easily check the interlock circuit as follows:

1. Connect the Intlk connector of the 4155/4156 to your interlock circuit.
2. Press **System** front-panel key, then select CALIB/DIAG primary softkey to display the SYSTEM: SELF-CALIBRATION/DIAGNOSTICS page.
3. In the CALIB/DIAG field, select DIAG secondary softkey.
4. In the CATEGORY field, select I/O PERIPH secondary softkey.
5. Move pointer to the `403 (INT.) Interlock LED` field.
6. Select EXECUTE secondary softkey.
7. Confirm the following:
   - LED turns on within 1 sec from when interlock circuit is shorted.
   - LED turns off within 1 sec from when interlock circuit is open.

To stop the interlock test, select STOP secondary softkey.

To Mount Connectors

This section provides the information needed to mount connectors for the Agilent B2200 output cable connections on the shielding panel. See this section if you do not use the connector plate.

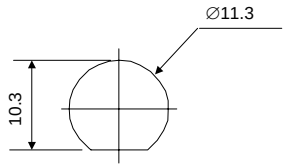
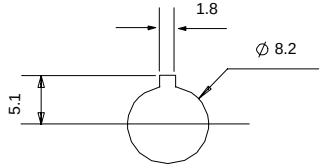
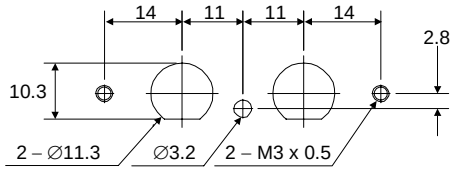
1. Get the appropriate parts for your situation. Refer to Table 2-5.
2. Make holes and mount the connectors. Refer to Table 2-6.

   For kelvin connections, use the Kelvin cables. The Kelvin cable requires the kelvin triaxial connector which has two connector holes and three screw holes.
3. Make an interlock circuit as shown in “To Make Interlock Circuit” on page 2-15.
4. Make cable connections to the DUT interface. Refer to “To Make Connections to DUT Interface” on page 2-13.

Table 2-5 **Recommended Parts**

Description	Agilent Part No.
Interlock Connector (6 pin, female)	1252-1419C
Switch	3101-0302 or 3101-3241
LED (V_F @ 2.1 V @ I_F = 10 mA)	1450-0641
Wire	8150-5680
Triaxial Connector (female)	1250-2457
Low Noise Coaxial Cable	8121-1191

Table 2-6 **Dimensions of Connector Holes**

Triaxial Connector (in mm)	Interlock Connector (in mm)
	
Kelvin Triaxial Connector (in mm)	
	

Input Connections

This section explains how to connect instruments to the Agilent B2200.

WARNING **Turn off all instruments that will be connected to the Agilent B2200. And do not turn them on until the connection described in this section is completed. If you ignore this warning, you may be exposed to dangerous voltage.**

The Agilent B2200 input connector has eight SMU input connectors and six AUX input connectors. Table 2-7 shows cables used to connect the instrument for typical applications using the Agilent B2200.

You can make the Kelvin connections when using the E5260/E5270/4142/4156 SMU or 41501 HPSMU. Then use cables as follows:

- Agilent 16493K Kelvin triaxial cable for Agilent E5260/E5270/4156/41501
- Agilent 16494B Kelvin triaxial cable for Agilent 4142B

To connect the Kelvin triaxial cable to the Agilent B2200 input, use pairs (couple ports) of the SMU input connectors (1&2, 3&4, 5&6, or 7&8). The input signal for each Kelvin input is as follows:

- Odd input port number: Force
- Even input port number: Sense

Ground Unit (GNDU) can sink over 1 A. For the measurement over 1 A, connect the GNDU to the connector plate directly by using the Agilent 16493H GNDU cable.

If you never perform the measurement over 1 A, you can connect the GNDU to the Agilent B2200 inputs. Then use the Agilent 16493N GNDU cable. This cable requires the Kelvin connection.

CAUTION Make sure current to the GNDU is less than 1 A if you connect GNDU to the Agilent B2200 inputs. The maximum input current of the Agilent B2200 is 1A.

Table 2-7 B2200 Input Connections

Application	Instrument		B2200 Input Connector	Cable Required
	Agilent Model No.	Output Connector		
DC Measurement	4155	MPSMU	SMU1 to 8	16494A triaxial cable
		VSU	AUX1 to 6	BNC cable
		VMU	AUX1 to 6	BNC cable
		Intlk	–	16493J interlock cable (for direct connection to connector plate)
	4156	HRSMU	SMU1 to 8	16493K Kelvin triaxial cable or 16494A triaxial cable
		VSU	AUX1 to 6	BNC cable
		VMU	AUX1 to 6	BNC cable
		Intlk	–	16493J interlock cable (for direct connection to connector plate)
	41501	HPSMU	SMU1 to 8	16493K Kelvin triaxial cable or 16494A triaxial cable
		MPSMU	SMU1 to 8	16494A triaxial cable
		PGU	AUX1 to 6	BNC cable
		GNDU	SMU1 to 8	16493N GNDU Kelvin cable
			–	16493H GNDU cable (for direct connection to connector plate)
	4142B	SMU	SMU1 to 8	16494B Kelvin triaxial cable or 16494A triaxial cable
		VSU	AUX1 to 6	BNC cable
		VMU	AUX1 to 6	BNC cable
		GNDU	SMU1 to 8	16493HN GNDU Kelvin cable
			–	16493H GNDU cable (for direct connection to connector plate)
		Intlk	–	16435A interlock cable adapter and 16493J interlock cable (for direct connection to Connector Plate)

Application	Instrument		B2200 Input Connector	Cable Required
	Agilent Model No.	Output Connector		
DC Measurement	E5260/ E5270	SMU	SMU1 to 8	16493K Kelvin triaxial cable or 16494A triaxial cable
		GNDU	SMU1 to 8	16493N GNDU Kelvin cable
			–	16493H GNDU cable (for direct connection to connector plate)
		Interlock	–	16493J interlock cable (for direct connection to connector plate)
C Measurement	C Meter	High, Low	CMH/CML	16494F CMU cable for 4 terminal pairs
Pulse Input	Pulse Generator	Output	AUX1 to 6	BNC cable
Bias Input	Power Supply	Output	AUX1 to 6	BNC cable

In the table above,

- CMH/CML connectors are a pair of the AUX inputs.
- The Agilent B2200 does not have the interlock connector. Connect directly from instrument to the connector plate which has an interlock connector.
- The Agilent 41422A/41423A (HCU/HVU) of the Agilent 4142B cannot be used with the Agilent B2200.
- To connect instrument output that uses banana plug to the AUX connector, use the dual banana plug to BNC adapter (Agilent part number 1251-2277).

Measurement Cable Length

This section describes how to calculate the total guard capacitance when using an SMU (source monitor unit). When using an SMU, the length of measurement cables is limited by the guard capacitance of the cables. The guard capacitance means the capacitance between the signal line (Force or Sense) and the Guard line.

Table 2-8 lists the guard capacitance for each element of the Agilent B2200's measurement environment.

When using the 4155/4156/4142B/E5260/E5270, the maximum limit of the guard capacitance is approximately 900 pF. So, you add the following and total must be less than 900 pF:

- Guard capacitance of cable from SMU to B2200 inputs.
- Guard capacitance of mainframe and modules.
- Guard capacitance of cable from B2200 outputs.
- Guard capacitance of cable from connector plate to DUT.
- Other capacitances, such as for probe card.

The following is an example to calculate the guard capacitance of a measurement environment:

Installed Plug-in cards: Four B2210As (145 pF + 8 pF × 3)

Input Cable: 16494A-003 (75 pF)

Output Cable: 16494A-001 (130 pF)

Cable from Connector Plate to DUT: 8121-1191, 1 m (130 pF)

Probe Card: Guard Capacitance approximately 10 pF (example)

In this environment, the total guard capacitance (`Cg-total`) is as follows.

```
Cg-total = 145+(8×3)+75+130+130+10 pF = 514 pF < 900 pF
```

Even if you use other instruments, you can use the table for reference about the measurement cable length and capacitance.

Table 2-8 Guard Capacitances of B2200 Measurement Environment (Typical)

Connection	Agilent Model/Part No.	Cable Length	Guard Capacitance
from SMU to B2200 inputs	16494A-003 (for non-Kelvin)	80 cm	75 pF
	16494A-001 (for non-Kelvin)	1.5 m	130 pF
	16494B-003 (for Kelvin, 4142B)	80 cm	90 pF
	16493K-001 (for Kelvin)	1.5 m	150 pF
mainframe and modules	B2210A (only 1 card is installed)	–	145 pF
	B2210A (more 1 card)	–	8 pF/extra card
	B2211A (only 1 card is installed)	–	145 pF
	B2211A (more 1 card)	–	8 pF/extra card
from B2200 outputs to connector plate or probe card interface	16494A-001 (for non-Kelvin)	1.5 m	130 pF
	16494A-002 (for non-Kelvin)	3 m	240 pF
	16494A-003 (for non-Kelvin)	4 m	340 pF
	16494B/C-001 (for Kelvin)	1.5 m	140 pF
	16494B/C-002 (for Kelvin)	3 m	260 pF
	16494C-003 (for Kelvin)	4 m	340 pF
from connector plate to DUT	Agilent Part No. 8121-1191	X m	130 pF per m
probe card interface	B2220A	–	70 pF

Maintenance

Maintenance should be performed periodically to keep the B2200 in good condition.

Calibration

Calibration must be performed periodically so that the instruments satisfy the specifications, and keep a good condition. It is recommended to perform a calibration once a year at least. For calibration, contact your nearest Agilent Technologies Service Center. Trained service personnel will perform calibration (performance verification).

Cleaning

Before performing cleaning, turn off the instrument, and disconnect power cable from the rear panel. Use a dry cloth to clean the external case parts.

To prevent electrical shock, do not perform cleaning when the instrument is turned on, and do not use a wet cloth.

3 Front Panel Operation

This chapter explains the front panel operation and the switch control functions of the Agilent B2200, also provides the reference information of the front panel keys and display.

- “Operation”
- “Switch Control Functions”
- “Display Functions”
- “Front Panel Keys”
- “Setup Menus”

Operation

This section describes operations of the Agilent B2200.

- “To Initialize Agilent B2200”
- “To Enable Light Pen”
- “To Change Channel Configuration Mode”
- “To Change Connection Rule”
- “To Change Connection Sequence”
- “To Control Switch Condition”
- “To Open All Switches”
- “To Save/Load Setup Data”
- “To Use Bias Mode”
- “To Use Ground Mode”
- “To Use Couple Mode”
- “To Display Firmware Revision”
- “To Display Module Information”
- “To Read Error Message”
- “To Set Beeper”
- “To Set GPIB Address”
- “To Set Remote Display Mode”
- “To Return to Local Mode”

NOTE

About moving cursor, selecting value, and changing display

Use the right/left arrow key to move the cursor to the desired function name. Use the up/down arrow key to select the value for the setup item.

The **Enter** key makes the setup effective, and returns the display to the previous menu or display.

The **Exit** key returns the display to the previous menu or display without making the setup effective.

To Initialize Agilent B2200

1. Press the **Shift** key and the **Local** key. Then the LCD will display NO.
2. Press the arrow key to displays YES, then press the **Enter** key to initialize the Agilent B2200, or press the **Exit** key to cancel initialization.

To Enable Light Pen

Turn the Agilent B2200 off, and connect the light pen to the Light Pen connector at the right down corner of the front panel. After that, perform the following procedure to enable the light pen.

1. Press the **Menu** key. The setup menu will be displayed on the LCD.
2. Press the arrow key to move the cursor to PEN, then press the **Enter** key.
3. Press the arrow key to display ENABLE, then press the **Enter** key to enable the light pen, or press the **Exit** key to cancel changing the setup.

NOTE

Light Pen

You can control the Agilent B2200 functions and the switch connections by using the front panel keys. And the Agilent B2200 allows you to use the Agilent 16443A Light Pen to control the switch connections.

Pointing a LED on the LED matrix by using the light pen controls the setting of the switch specified by the LED.

To Change Channel Configuration Mode

1. Press the **Shift** key and the **Bias Mode** key. The LCD displays the present setting (AUTO or NORMAL).
2. Press the arrow key to select the mode, then press the **Enter** key. The LCD displays NO.
3. Press the arrow key to display YES, then press the **Enter** key. Or press the **Exit** key to cancel this operation.

Changing the channel configuration mode resets the Agilent B2200.

To Change Connection Rule

1. Press the **Rule** key. The LCD displays the present setting (FREE or SINGLE).
2. Press the arrow key to select the connection rule, then press the **Enter** key. Or press the **Exit** key to cancel this operation.

To Change Connection Sequence

1. Press the **Shift** key and the **Rule** key. The LCD displays the present setting (Break_Before_Make, Make_Before_Break, or No_Sequence).
2. Press the arrow key to select the connection sequence, then press the **Enter** key. Or press the **Exit** key to cancel this operation.

To Control Switch Condition

If you use the light pen, you do not need the following instruction to control the switch condition.

1. If you are NOT watching the orange-blink-LED on the LED matrix, press the **Open/Close** key. The blink-LED will appear.
2. Press the arrow keys to move the blink-point.
3. Press the **Open/Close** key to open/close the switch specified by the blink-LED. The green-LEDs indicate the switches that are closed now.
4. Repeat *2* and *3* until the switch setup is completed.

   Blinking of LED will be stopped by pressing the front panel key other than the **Open/Close**, **Fast**, or arrow keys.

NOTE

When Kelvin cables are connected to Outputs

For the Kelvin outputs, the input-output paths must be controlled as shown below.

- For the input couple port:

  Control the switches to connect the input couple port to the Kelvin output.

- For the single input port:

  Control the switches to connect the input port to two ports of the Kelvin output.

If you do not comply with this note, leakage current between the Kelvin paths will cause measurement error.

To Open All Switches

1. Press the **Open All** key.
2. Press the arrow key to display YES, then press the **Enter** key.

NOTE

Status after this operation

When the bias mode is ON, the bias-enabled output ports will be connected to the input bias port.

When the ground mode is ON, the ground-enabled input/output ports will be connected to the input ground port.

To Save/Load Setup Data

The Agilent B2200 provides the internal memory used to save the setup condition. Eight setup conditions can be saved into the memory.

To save the setup

1. Press the **Shift** key and the **Load Memory** key.
2. Press the arrow key to select the internal memory (01 to 08).
3. Press the **Enter** key to save the setup. Or press the **Exit** key to cancel this operation.

   Wait until the save operation is completed. Then, the LCD displays the status and setup conditions.

To load the setup

1. Press the **Load Memory** key.
2. Press the arrow key to select the internal memory (01 to 08).
3. Press the **Enter** key to load the setup. Or press the **Exit** key to cancel this operation. Wait until the load operation is completed. Then, the LCD displays the status and setup conditions.

To Use Bias Mode

Bias mode cannot be set to ON when the ground mode is ON.

1. Change the bias-enabled output ports.
   a. Press the **Shift** key and the **Port Function** key.
   b. Move the cursor to SET, then press the **Enter** key.
   c. Move the cursor to DISABLE, then press the **Enter** key.

      The LCD displays one of the bias-enabled output port numbers which can be changed to the bias-disabled. Or if there is no bias-enabled output port, the LCD displays `Channel: No Channel`. Press the arrow key to select the output port to be changed to the bias-disabled, then press the **Enter** key.
   d. Move the cursor to ENABLE, then press the **Enter** key.

      The LCD displays one of the bias-disabled output port numbers which can be changed to the bias-enabled. Or if there is no bias-disabled output ports, the LCD displays `Channel: No Channel`. Press the arrow key to select the output port to be changed to the bias-enabled, then press the **Enter** key.
   e. Repeat *c* and *d* until the bias-enabled port setup is completed. After that, press the **Exit** key more than once to display the status and setup conditions.
2. Press the **Bias Mode** key to set the bias mode ON. Pressing the key again sets the mode OFF.
3. Change the bias port (default setting: 10).
   a. When the bias mode is ON, press the **Port Function** key. The blink-cursor appears on the first line of the LCD.
   b. Press the right/left arrow key to move the cursor on the input port number (01 to 14) that will be set to the input bias port.
   c. Press the up/down key to display `B`, then press the **Enter** key.

To Use Ground Mode

Ground mode cannot be set to ON when the bias mode is ON.

1. Change the ground-enabled output ports.
   a. Press the **Shift** key and the **Open All** key.
   b. Move the cursor to SET, then press the **Enter** key.
   c. Move the cursor to ENABLE, then press the **Enter** key.

      The LCD displays one of the ground-disabled output port numbers which can be changed to the ground-enabled. Or if there is no ground-disabled output ports, the LCD displays `Channel: No Channel`. Press the arrow key to select the output port to be changed to the ground-enabled, then press the **Enter** key.
   d. Move the cursor to DISABLE, then press the **Enter** key.

      The LCD displays one of the ground-enabled output port numbers which can be changed to the ground-disabled. Or if there is no ground-enabled output port, the LCD displays `Channel: No Channel`. Press the arrow key to select the port to be changed to the ground-disabled, then press the **Enter** key.
   e. Repeat *c* and *d* until the ground-enabled port setup is completed. After that, press the **Exit** key more than once to display the status and setup conditions.
2. Press the **Shift** key and the **Couple Mode** key to set the ground mode ON. Performing this operation again sets the mode OFF.
3. Change the ground port (default setting: 12).
   a. When the ground mode is ON, press the **Port Function** key. The blink-cursor appears on the first line of the LCD.
   b. Press the right/left arrow key to move the cursor on the input port number (01 to 14) that will be set to the input ground port.
   c. Press the up/down key to display `G`.
4. Change the ground-enabled input ports (multiple ports can be set). Repeat *a* and *b* for the all ground-enabled input ports, then press the **Enter** key.
   a. Press the right/left arrow key to move the cursor on the input port number (01 to 08) that will be set to the ground-enabled input port.
   b. Press the up/down key to display `-`.

   Open the ground-enabled input ports to prevent the instrument from damage.

To Use Couple Mode

1. Press the **Couple Mode** key to set the couple mode ON. Pressing the key again sets the mode OFF.
2. Perform the input couple port detection.
   a. Press the **Menu** key. The setup menu will be displayed on the LCD.
   b. Move the cursor to SCAN, then press the **Enter** key. The LCD displays NO.
   c. Press the arrow key to display YES, then press the **Enter** key.
   d. Press the **Exit** key.
3. Change the couple ports (multiple ports can be set).
   a. When the couple mode is ON, press the **Port Function** key. The blink-cursor appears on the first line of the LCD.
   b. Press the right/left arrow key to move the cursor on the input port number (01 to 14) that will be set to the input couple port.
   c. Press the up/down key to display `C`.
   d. Repeat *b* and *c* for the all couple ports, then press the **Enter** key.

To Display Firmware Revision

1. Press the **Menu** key. The setup menu will be displayed on the LCD.
2. Move the cursor to CONFIG, then press the **Enter** key.
3. Move the cursor to REVISION, then press the **Enter** key. The firmware revision is displayed.

To Display Module Information

1. Press the **Menu** key. The setup menu will be displayed on the LCD.
2. Move the cursor to CONFIG, then press the **Enter** key.
3. Move the cursor to UNIT, then press the **Enter** key. The module information is displayed.
4. Press the arrow keys to display another module information item.

To Read Error Message

1. Press the **Menu** key. The setup menu will be displayed on the LCD.
2. Move the cursor to ERROR, then press the **Enter** key.
3. Move the cursor to DISPLAY, then press the **Enter** key to display the message.
4. Press the arrow keys to read another error message. A maximum of four error messages can be stored.

To clear error buffer

1. Press the **Menu** key. The setup menu will be displayed on the LCD.
2. Move the cursor to ERROR, then press the **Enter** key.
3. Move the cursor to CLEAR, then press the **Enter** key. The LCD displays NO.
4. Press the arrow key to display YES, then press the **Enter** key to clear the error buffer, or press the **Exit** key to cancel operation.

To Set Beeper

1. Press the **Menu** key. The setup menu will be displayed on the LCD.
2. Move the cursor to BEEP, then press the **Enter** key.
3. Press the arrow keys to select the beep ON or OFF.
4. Press the **Enter** key to make the setup effective, or press the **Exit** key to cancel changing the setup.

To Set GPIB Address

1. Press the **Menu** key. The setup menu will be displayed on the LCD.
2. Move the cursor to CONFIG, then press the **Enter** key.
3. Move the cursor to ADDRESS, then press the **Enter** key.
4. Press the arrow keys to set the GPIB address.
5. Press the **Enter** key to make the setup effective, or press the **Exit** key to cancel changing the setup. To be effective the new address, reboot the Agilent B2200.

To Set Remote Display Mode

This instruction enables or disables the data display in the GPIB remote condition. See “RMT_DSPL” on page 3-33.

LCD

1. Press the **Menu** key. The setup menu will be displayed on the LCD.
2. Move the cursor to RMT_DSPL, then press the **Enter** key.
3. Move the cursor to LCD, then press the **Enter** key.
4. Press the arrow keys to set the remote display mode ON or OFF.
5. Press the **Enter** key to make the setup effective, or press the **Exit** key to cancel changing the setup.

LED matrix

1. Press the **Menu** key. The setup menu will be displayed on the LCD.
2. Move the cursor to RMT_DSPL, then press the **Enter** key.
3. Move the cursor to LED, then press the **Enter** key.
4. Press the arrow keys to set the remote display mode ON or OFF.
5. Press the **Enter** key to make the setup effective, or press the **Exit** key to cancel changing the setup.

To Return to Local Mode

Press the **Local** key. If the front panel keys are locked, send the :SYST:KLC command from an external computer, then press the **Local** key.

Switch Control Functions

This section introduces the switch control functions of the Agilent B2200.

- “Channel Configuration Mode”
- “Connection Rule”
- “Connection Sequence”
- “Bias Mode”
- “Ground Mode”
- “Couple Mode”

Channel Configuration Mode

The Agilent B2200 provides the two channel configuration modes, Normal and Auto. The configuration mode defines the way to control multiple switch modules installed in the mainframe.

Normal

Each module is considered independently. So each module is always a 12 output switching matrix.

The switch control functions need to be defined for each module.

Auto

Default mode at Power On or *RST command.

To use this mode, the same type of module must be installed in the mainframe from slot number 1 continuously (slots 1 to 2; or slots 1 to 3; or slots 1 to 4).

The installed modules are treated as one switching matrix. For example, if the modules are installed in slots 1 to 3, the Agilent B2200 works as a 36 output switching matrix.

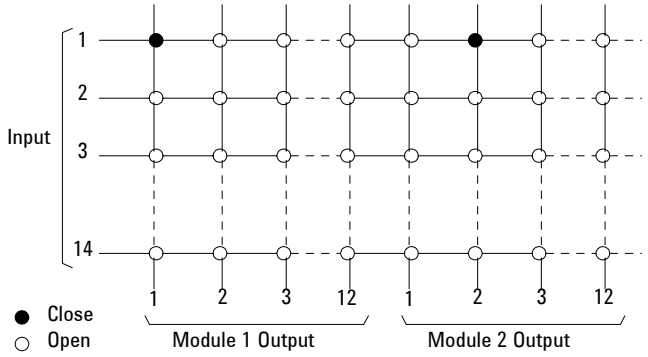
The switch control functions are available for the switching matrix.

Connection Rule

Connection rule is used to specify if an input or output port can have multiple connections. For each module installed in the mainframe (for auto configuration mode, installed modules are treated as one module), you can specify one of the following connection rules:

Single: Each input port can be connected to *only one* output port, and each output port can be connected to *only one* input port. So, existing connection to a port will be disconnected when a new connection is made.

If normal configuration mode is set to the Agilent B2200 with multiple modules, an input/output path is effective for each module. For example, if normal configuration mode is set to the Agilent B2200 with two modules, and single rule is set to both modules, the following connection is possible.



Free: Each input port can be connected to *multiple* output ports, and each output port can be connected to *multiple* input ports.

CAUTION If the Free connection rule has been specified, ensure multiple input ports are not connected to the same output port. Such configurations can cause damage.

Connection Sequence

NOTE This is only for modules that are set to the single connection rule. Refer to “Connection Rule” on page 3-14.

Connection sequence specifies the open/close sequence of the relays when changing from an existing connection to a new connection.

You can select one of the three connection sequences shown in Table 3-1 for each module installed in the Agilent B2200.

When an existing connection is changed to a new connection, the relays are opened/closed as follows:

Table 3-1 Connection Sequence

Connection Sequence	Relay Operation
Break Before Make	1. Disconnect previous route. 2. Wait for relays to open. 3. Connect new route.
Make Before Break	1. Connect new route. 2. Wait for relays to close. 3. Disconnect previous route.
No Sequence	1. Disconnect previous route. 2. Connect new route.

Bias Mode

Bias mode is useful for connecting the same input to multiple channels (output ports) simultaneously. And the connections will be kept until the other input port connection will be changed.

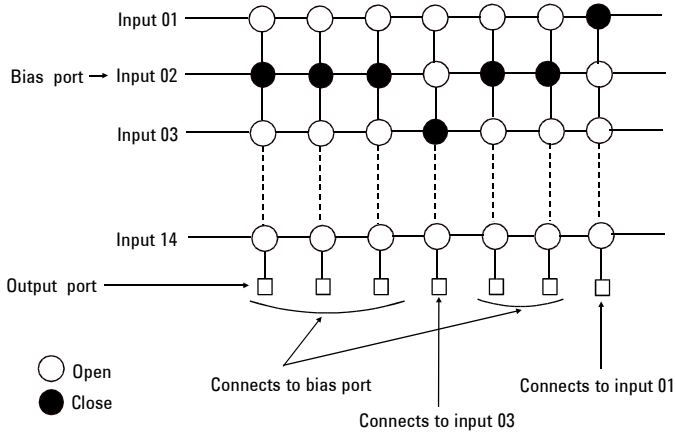
When the bias mode is ON, the input bias port is connected to all *bias enabled* output ports that are not connected to any other input ports. You cannot directly control which output ports are connected to the input bias port:

- If another input port is disconnected from a *bias enabled* output port, the output port is automatically connected to the input bias port.
- If another input port is connected to a *bias enabled* output port, the output port is automatically disconnected from the input bias port.
- *Bias disabled* output ports are never connected to the input bias port when the bias mode is ON.
- You can independently set the bias port and control the bias mode for each module when the configuration mode is normal.

When the bias mode is OFF, the input bias port is the same as the other input ports, so relays can be controlled directly to connect to output ports.

Figure 3-1 shows an example. Input 2 is the input bias port. When the bias mode is turned ON, all *bias enabled* output ports (that are not connected to other input ports) are connected to the input bias port. So, the output ports that are connected to input port 1 and 3 are not connected to the input bias port.

Figure 3-1 **Example of Bias Mode**



NOTE

Connection rule cannot be specified for the input bias port, which can always be connected to multiple output ports.

Connection sequence (to connect input bias port to output ports) is always Break-Before-Make.

Bias mode cannot be set to ON when the ground mode is ON.

If the bias input port and a couple port have been assigned to the same input port, the bias mode and the couple mode cannot be used in parallel.

Ground Mode

Ground mode operation is similar to the bias mode operation. The ground mode is useful for connecting the same input to multiple channels (output ports) and the unused input ports simultaneously. And the connections will be kept until the other input port connection will be changed. The ground mode is especially useful for settling the potential of the unused input/output paths.

If you assign the input port 12 (AUX Input 12) as the ground port, open the input port 12. This ground port will be internally connected to the ground when the ground mode is set to ON.

When the ground mode is ON, the input ground port is connected to all *ground enabled* input ports (unused ports) and the *ground enabled* output ports that are not connected to any other input ports. You cannot directly control which output ports are connected to the input ground port:

- If another input port is disconnected from a *ground enabled* output port, the output port is automatically connected to the input ground port.
- If another input port is connected to a *ground enabled* output port, the output port is automatically disconnected from the input ground port.
- *Ground disabled* output ports are never connected to the input ground port when the ground mode is ON.
- You can independently set the ground port and control the ground mode for each module when the configuration mode is normal.

When the ground mode is OFF, the input ground port is the same as the other input ports, so relays can be controlled directly to connect to output ports.

NOTE

Connection rule cannot be specified for the input ground port, which can always be connected to multiple output ports.

Connection sequence (to connect input ground port to output ports) is always Break-Before-Make.

Ground mode cannot be set to ON when the bias mode is ON.

The input ground port and a ground enabled input port cannot be assigned to the same input port.

If the ground input port and a couple port have been assigned to the same input port, the ground mode and the couple mode cannot be used in parallel.

If a ground enabled input port and a couple port have been assigned to the same input port, the ground mode and the couple mode cannot be used in parallel.

CAUTION

Opening the ground enabled input ports

Open the *ground enabled* input ports (unused input ports). If any equipment is connected to the *ground enabled* input ports, turning the ground mode ON may cause damage in the equipment.

Couple Mode

Couple mode is useful for making the Kelvin connections. When the couple mode is ON, the input couple ports will be connected to the output couple ports. For the available couple ports, see Table 3-2.

- For the couple port connections, the odd/even number of the input port will be connected to the odd/even number of the output port respectively. Then the even number is always the odd number plus 1.
- You can independently specify the same or different couple ports and control the couple mode for each module when the configuration mode is normal.

Table 3-2 **Input Couple Port Numbers and Output Couple Port Numbers**

Available input couple port No.	Input ports	Available output couple port No.
1	SMU 1, 2	1 and 2, 3 and 4, . . . , 11 and 12 (for normal configuration mode) 1 and 2, 3 and 4, . . . , 47 and 48 (for auto configuration mode)
3	SMU 3, 4	
5	SMU 5, 6	
7	SMU 7, 8	
9	AUX 9, 10	
11	AUX 11, 12	
13	AUX 13, 14 (CMH, CML)	

For example, if you specify the SMU input 1 for the couple port and set the couple mode ON, the input 1 will be connected to an odd number of the output port and the input 2 will connected to the next number of the output port. And if you specify to connect the input 1 to the output 10, the input 1 will be connected to the output 9 and the input 2 will be connected to the output 10.

NOTE

If the bias input port and a couple port have been assigned to the same input port, the bias mode and the couple mode cannot be used in parallel.

If the ground input port and a couple port have been assigned to the same input port, the ground mode and the couple mode cannot be used in parallel.

If a ground enabled input port and a couple port have been assigned to the same input port, the ground mode and the couple mode cannot be used in parallel.

NOTE

Couple Port Detection Function

The Agilent B2200 provides the function to detect the input ports that connect the Kelvin triaxial cable and set the ports as the couple port automatically. See “SCAN” on page 3-32

Display Functions

The Agilent B2200 provides LED matrix, LCD, and 18 front panel keys for front panel operation. This section explains the display of the LED matrix and the LCD.

- “LED Matrix”
- “LCD”

LED Matrix

Agilent B2200 has four blocks of 14 × 12 LED matrix. They display the switch condition of the switch modules installed in the slot 1 to slot 4. See Table 3-3.

Also LEDs labeled Card 1 to Card 4 are located above the LED matrices. They indicate the status of the module installed in the slot 1 to 4, respectively. See Table 3-4.

Table 3-3 **LED Matrix**

LED color	Explanation
Green	The switch has been closed to connect the output channel to the input port.
Red	The switch has been closed to connect the output channel to the input bias port or the input ground port.
Orange	The LED also blinks. The switch condition can be changed by the **Open/Close** key.
-	The LED lights out. The switch has been opened.

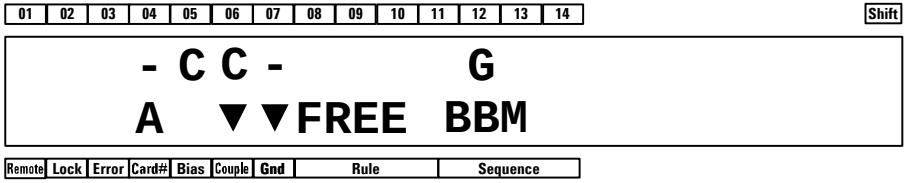
Table 3-4 **Card 1/2/3/4 LED**

LED color	Explanation
Red	The switch module has failed the selftest or the diagnostics.
Green	The switch module has operated normally.
-	The LED lights out. No switch module has been installed in this slot.

LCD

The LCD displays the setup information and the status information as shown in Table 3-5. Display example is shown in Figure 3-2.

Figure 3-2 **LCD Display Example**



The first line shows the input port status, couple port, bias port, ground port, or ground enabled port.

The second line shows the instrument status and the mode status.

The example of Figure 3-2 notifies you the following information.

- Input 5 and 6 are a couple port.
- Input 12 is the input ground port.
- Input 4 and 7 are the ground enabled input port.
- Channel configuration mode is auto.
- Couple mode is ON.
- Ground mode is ON.
- Connection rule is free.
- Connection sequence is break before make.

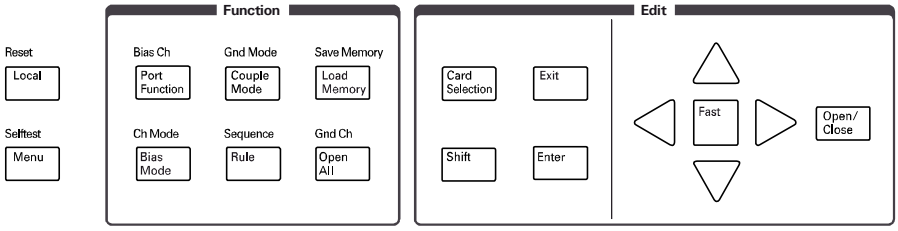
Table 3-5 LCD Display Items

Label	Description
01 to 14	Port function assigned to the input ports 1 to 14. `B` (bias port), `C` (couple port), `G` (ground port), `-` (ground enabled port), or blank (no function).
Shift	Shift key status indicator. The triangle mark appears when the sub key is active.
Remote	Remote status indicator. The triangle mark appears when the Agilent B2200 is in the GPIB remote condition.
Lock	Key status indicator. The triangle mark appears when the front panel keys are locked by an external computer.
Error	Error status indicator. The triangle mark appears when any error has occurred.
Card#	Slot number of the switch module to be monitored. Displays `A` when the channel configuration mode is Auto. In the auto mode, the modules installed in the mainframe from slot number 1 continuously will be controlled as one module. Or displays `1` to `4` when the channel configuration mode is Normal. The module can be selected by the **Card Selection** key.
Bias	Bias mode status indicator. The triangle mark appears when the mode is ON.
Couple	Couple mode status indicator. The triangle mark appears when the mode is ON.
Gnd	Ground mode status indicator. The triangle mark appears when the mode is ON.
Rule	Connection rule, `FREE` (plural route mode) or `SINGLE` (single route mode).
Sequence	Connection sequence, `BBM` (Break Before Make), `MBBR` (Make Before Break), or `NO_SEQ` (No Sequence).

NOTE In the remote mode and the default setting, only the Remote, Lock, and Error indicators are available. To display all information, set the RMT_DSPL function ON. Refer to “RMT_DSPL” on page 3-33.

Front Panel Keys

The Agilent B2200 provides LED matrix, LCD, and 18 front panel keys for front panel operation. The front panel keys are used to change the instrument settings, the switch conditions, and so on.



Local Sets the Agilent B2200 to the local condition.

Reset (Shift+Local) Used to reset the Agilent B2200.

Displays the following message. Press the arrow key to set YES, and then press the **Enter** key to reset the instrument.

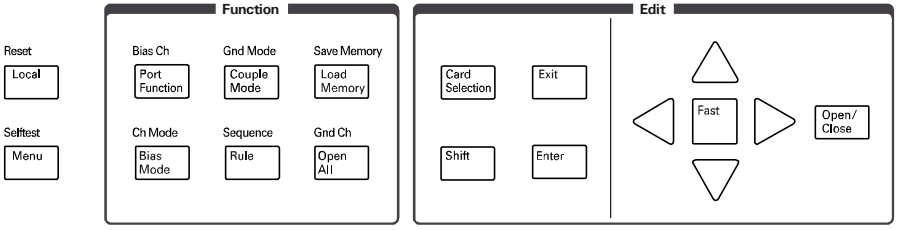
```
NO
```

Menu Displays the setup menu. See “Setup Menu” on page 3-30.

Selftest (Shift+Menu) Displays the selftest menu. See “Selftest Menu” on page 3-34.

Function key group

The Function key group is used to change the input ports and modes.



Port Function

Enters into the port function selection mode. In this mode, the arrow keys, **Fast** key, **Exit** key, and **Enter** key are available. Other keys will work to exit this mode.

In this mode, move cursor right or left to specify the input port, and press the up or down arrow key to select the port function, B (bias port), C (couple port), G (ground port), or - (ground enable port). The port function can be selected when the corresponding port operation mode (bias mode, couple mode, or ground mode) is set to ON. The bias mode and the ground mode cannot be set to ON simultaneously.

Bias Ch (Shift+ Port Function)

Displays the following menu.

```
SET  VIEW
```

- SET displays the following menu. The following functions are used to set the bias-enabled or bias-disabled channel (output port).

  ```
  ENABLE  DISABLE
  ```

  The function displays the following message for example. And then press **Enter** to bias-enable or bias-disable the channel.

  ```
  Channel: 01
  ```

  If there is no enabled or disabled channel, the following message will appear.

  ```
  Channel: No Channel
  ```

- VIEW displays the following message for example, and is used to see the bias status of the channel.

  ```
  Channel 01: ENABLED
  ```

Bias Mode

Sets the bias mode ON or OFF.

When the bias mode is set to ON, the LCD shows which input port is the bias port, and the input bias port will be connected to the bias-enabled channels that are not connected to other input port. And LEDs will be turned red to show the bias port connections.

Ch Mode (Shift+ Bias Mode)

Sets the channel configuration mode AUTO or NORMAL.

Changing the mode will reset the Agilent B2200 settings.

Couple Mode

Sets the couple mode ON or OFF.

When the couple mode is set to ON, the LCD shows which input ports are the couple port.

Gnd Mode (Shift+ Couple Mode)

Sets the ground mode ON or OFF.

When the ground mode is set to ON, the LCD shows which input port is the ground port, and the input ground port will be connected to the ground-enabled channels that are not connected to other input port. And LEDs will be turned red to show the ground port connections. The ground enabled input ports are also connected to the input ground port. Nothing must be connected to the ground enabled input ports.

Rule

Displays the following message. Selects the connection rule FREE (plural route connections) or SINGLE (single route connection).

```
FREE
```

Sequence (Shift+Rule)

Displays the following message. Selects the connection sequence Break_Before_Make, Make_Before_Break, or No_Sequence.

```
Break_Before_Make
```

Load Memory

Displays the following message. Used to select the Agilent B2200 setup data stored in the internal memory, and loads the data.

```
Settings: 01 [                ]
```

Save Memory (Shift+ Load Memory)

Displays the following message. Used to select the internal memory to store the Agilent B2200 setup data, and stores the data. Up to eight setup data can be saved.

```
Settings: 01 [                ]
```

Open All

Displays the following message. Press the arrow key to set YES, and then press the **Enter** key to open all relays.

```
NO
```

Gnd Ch (Shift+Open All)

Displays the following menu.

`SET  VIEW`

- SET displays the following menu. The following functions are used to set the ground-enabled or ground-disabled channel (output port).

  `ENABLE  DISABLE`

  The function displays the following message for example. And then press **Enter** to ground-enable or ground-disable the channel.

  `Channel: 01`

  If there is no enabled or disabled channel, the following message will appear.

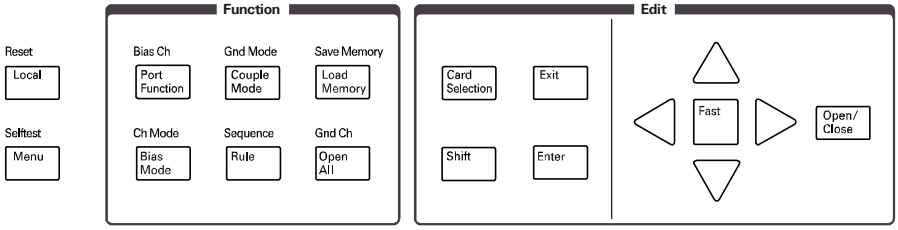
  `Channel: No Channel`

- VIEW displays the following message for example, and is used to see the ground status of the channel.

  `Channel 01: ENABLED`

Edit key group

The Edit key group is used to select the switch module to be monitored, move the cursor in the display, make the setup value effective, return to the previous menu or display, and so on.



Card Selection Selects the switch module to be monitored on the LCD. The Card# status indicator will change the slot number (card number) when the **Card Selection** key is pressed.

This key is not effective when the Card# indicator shows A (auto configuration mode).

Shift Enables the sub key function. The sub key label has been printed on the front panel above the key. The label color is blue.

Exit Returns the display to the previous menu or display without making the setup effective.

Enter Makes the setup effective, and returns the display to the previous menu or display.

Fast Used with the arrow key. Pressing the **Fast** key and an arrow key speeds up changing the setting value.

arrow keys Moves the cursor on the display, displays another selection for a setup message, or changes the value of the digit specified by the cursor.

For the LED matrix, moves the blink-LED.

Open/Close When no blink-LED is on the LED matrix, enters into the LED matrix based switch control mode. The blink-LED will appear. In this mode, the arrow keys and **Fast** key are available. Other keys will work to exit this mode.

When the blink-LED is on the LED matrix, changes the condition, open or close, of the switch specified by the blink-LED.

Setup Menus

This section explains the following setup menus displayed by pressing the **Menu** key or **Selftest** key.

- “Setup Menu”
- “Selftest Menu”

Setup Menu

Press the **Menu** key. The setup menu will be displayed on the LCD as shown in the following example. The setup menu is used to change the GPIB address, detect the couple port automatically, and so on.

```
 [Hardware Configuration]
 CONFIG  SCAN  ERROR  RMT_DSPL  BEEP >
```

```
 [Hardware Configuration]
<SCAN  ERROR  RMT_DSPL  BEEP  PEN
```

Press the arrow key to move the cursor to the desired function name. Then, press the **Enter** key. The setup message or the sub menu will be displayed. To return to the previous menu, press the **Exit** key.

Function Tree

The setup menu provides the following functions.

- CONFIG
  - ADDRESS Sets the GPIB address.
  - REVISION Displays the firmware revision.
  - UNIT Displays the module information of each slot.
- SCAN Detects and sets the input couple ports automatically.
- ERROR
  - DISPLAY Displays the error code and error message.
  - CLEAR Clears the error buffer.
- RMT_DSPL
  - LCD Selects on or off for the LCD display in the remote mode.
  - LED Selects on or off for the LED matrix in the remote mode.
- BEEP Selects on or off for the beeper.
- PEN Enables or disables the light pen.

CONFIG

Displays the sub menu that provides the following functions.

- `ADDRESS`

  Displays the following message.

  `GPIB Address =` *Address*

  Press the arrow key to set the desired GPIB address. Then, press the **Enter** key to make the setup effective, or press the **Exit** key to cancel changing the setup.

- `REVISION`

  Displays the following message.

  X.XX.XX

  where *X.XX.XX* shows the firmware revision.

  To return to the previous menu, press the **Exit** key.

- `UNIT`

  Displays the following message.

  `Slot#:` *model*`,` *X*

  where # is 1, 2, 3, or 4, *model* is the model number of the module, *X* is the revision of the module.

  To display another message, press the arrow key.

  To return to the previous menu, press the **Exit** key.

SCAN

Displays the following message.

`NO`

Press the arrow key to set YES. Then, press the **Enter** key to detect and set the input couple ports automatically, or press the **Exit** key to cancel this operation. The input couple ports will be the input ports the Kelvin cable is connected.

ERROR Displays the sub menu that provides the following functions.

- `DISPLAY`

  Displays the error code and error message, or `No Error`.

  To return to the previous menu, press the **Exit** key.

- `CLEAR`

  Displays the following message. Press the arrow key to set YES. Then, press the **Enter** key to clear the error buffer, or press the **Exit** key to cancel this operation.

  `NO`

RMT_DSPL Displays the sub menu that provides the following functions.

- `LCD`

  Displays the following message. Press the arrow key to set ON (displays all status information in the GPIB remote mode) or OFF (displays Remote, Lock, and Error only). Then, press the **Enter** key to make the setup effective, or press the **Exit** key to cancel changing the setup.

  `OFF` *or* `ON`

- `LED`

  Displays the following message. Press the arrow key to set ON (enables LED matrix in the GPIB remote mode) or OFF (disables it). Then, press the **Enter** key to make the setup effective, or press the **Exit** key to cancel changing the setup.

  `ON` *or* `OFF`

BEEP Displays the following message. Press the arrow key to set the beeper ON or OFF. Then, press the **Enter** key to make the setup effective, or press the **Exit** key to cancel changing the setup.

`ON` *or* `OFF`

PEN Displays the following message. Press the arrow key to enable or disable the light pen. Then, press the **Enter** key to make the setup effective, or press the **Exit** key to cancel changing the setup.

`DISABLE` *or* `ENABLE`

Selftest Menu

Press the **Shift** key and the **Menu** key. The selftest menu is displayed. The menu is used to execute the selftest and diagnostics.

```
 [Execute Diagnostics]
 SELF_TEST  RELAY_TEST  KEY  BEEPER >
```

```
 [Execute Diagnostics]
<KEY  BEEPER  LED  PEN  GPIB
```

Press the arrow key to move the cursor to the desired function name. Then, press the **Enter** key. The setup message or the sub menu will be displayed. To return to the previous menu, press the **Exit** key.

Function Tree

This menu provides the following functions.

- `SELFTEST` Executes the controller test or displays test result.
- `RELAY_TEST` Executes the relay test or displays test result.
- `KEY` Executes the front panel interface test or displays test result.
- `BEEPER` Executes the beeper test or displays test result.
- `LED` Executes the LED matrix test or displays test result.
- `PEN` Executes the light pen test or displays test result.
- `GPIB` Executes the GPIB test or displays test result.

SELF_TEST Displays the sub menu that provides the following functions.

- `EXECUTE`

  Starts the controller test. Wait until PASS or FAIL is displayed. Then press the **Exit** key to return to the previous menu.

- `RESULT`

  Displays the test result. Press the **Exit** key to return to the previous menu.

RELAY_TEST Displays the sub menu that provides the following functions.

Before starting the relay test, disconnect cables from the input connectors. And open the outputs (end of cable is OK). For the Kelvin cable, disconnect it from the output connectors.

- `EXECUTE`

  Displays the following message.

  ```
  Slot1
  ```

  Press the up or down arrow key to select the module to be tested. Then press the **Enter** key to start the relay test, or press the **Exit** key to cancel this operation.

  Number of modules is 2 or more, the relay test will be automatically completed. However, if the only one module is installed, the following message will appear.

  ```
  Connect IV1 and 2. Press [Enter].
  ```

  Then connect a cable between the input 1 and 2, and press **Enter** key.

  After that, change the cable connection as shown in the displayed message and repeat this for the other input connections (input 3 and 4, 5 and 6, 7 and 8, 9 and 10, 11 and 12, 13 and 14). Do not forget to open the connectors other than the specified pair.

- `RESULT`

  Displays the following message (example). Press the up or down arrow key to display the test result for each module. Press the **Exit** key to return to the previous menu.

  ```
  Slot1: Not performed yet
  ```

KEY

Displays the sub menu that provides the following functions.

- `EXECUTE`

  Displays the following message.

  ```
  DIAG:KEY   Press any key.
  ```

  Press any front panel key and confirm the LCD display. For example, if you press the **Port Function** key, the following message must be displayed.

  ```
  DIAG:KEY   [Port Function]
  ```

  Continue this for all keys. After that, press the **Enter** key twice for the normal operation. The test result will be PASS.

  If you find any wrong response, press the **Exit** key twice. The test result will be FAIL.

  Finally, press the **Exit** key to return to the previous menu.

- `RESULT`

  Displays the test result. Press the **Exit** key to return to the previous menu.

BEEPER

Displays the sub menu that provides the following functions.

- `EXECUTE`

  Starts the beeper test, and displays the following message.

  ```
  DIAG:BEEP   Is beeper making 2 sounds?
  ```

  Press the **Enter** key if the beeper works correctly. The test result will be recorded as PASS.

  If you find any problem, press the **Exit** key. The test result will be recorded as FAIL.

  Finally, press the **Exit** key to return to the previous menu.

- `RESULT`

  Displays the test result. Press the **Exit** key to return to the previous menu.

LED

Displays the sub menu that provides the following functions.

- `EXECUTE`

  Starts the LED matrix test, and displays the following message.

  ```
  DIAG:LED   All LED in Orange?
  ```

  Press the **Enter** key if the all LEDs are lighted in orange. The test result will be recorded as PASS.

  If you find any problem, press the **Exit** key. The test result will be recorded as FAIL.

  Finally, press the **Exit** key to return to the previous menu.

- `RESULT`

  Displays the test result. Press the **Exit** key to return to the previous menu.

PEN

Displays the sub menu that provides the following functions.

Before starting the light pen test, connect the light pen to the Agilent B2200.

- `EXECUTE`

  Starts the light pen test, and displays the following message.

  ```
  DIAG:PEN   Point any cross point
  ```

  Point the light pen to the point you desire and confirm the LCD display. For example, if you point the input 5-to-output 10 cross point of the Agilent B2200 in the auto configuration mode, the following message must be displayed.

  ```
  SLOT: 0 INPUT: 5 OUTPUT:10
  ```

  Continue this for all cross points. After that, press the **Enter** key for the normal operation. The test result will be recorded as PASS.

  If you find any wrong response, press the **Exit** key. The test result will be recorded as FAIL.

  Finally, press the **Exit** key to return to the previous menu.

- `RESULT`

  Displays the test result. Press the **Exit** key to return to the previous menu.

GPIB

Displays the sub menu that provides the following functions.

- `EXECUTE`

  Displays the following message.

  ```
  Open GPIB, then press [Enter]
  ```

  Disconnect the cable from the GPIB connector on the rear panel, and open it.

  Press the **Enter** key to start the GPIB test, and wait until PASS or FAIL is displayed. Then press the **Exit** key to return to the previous menu.

- `RESULT`

  Displays the test result. Press the **Exit** key to return to the previous menu.

4 Programming

This chapter describes the automatic control programming of the Agilent B2200.

- “Programming Basics”

  Explains the commands for the fundamental switch control of the Agilent B2200.

- “Programming Examples”

  Provides some examples of the programming.

- “Capacitance Compensation”

  Explains how to use the capacitance compensation routine. The routine is a function of the Agilent B2200 VXI*plug&play* driver.

For the details about SCPI commands, see Chapter 5.

For the details about VXI*plug&play* driver, see Chapter 6.

Programming Basics

This section explains the commands used for the fundamental switch control of the Agilent B2200.

- “SCPI Command Hierarchy”
- “Fundamental Commands”
- “Switch Control”

SCPI Command Hierarchy

The SCPI commands use a hierarchical structure for subsystem commands similar to a file system. For example, in `:ROUT:CONN:RULE` command, the hierarchy is as follows:

ROUT	root
CONN	sub-level 1
RULE	sub-level 2

The colon at the beginning of the command means root.
The colons between two command keywords means moving down to a lower level.

A semicolon enables two commands to be sent on the same line.
For example, `:ROUT:CONN:RULE ALL,FREE;SEQ ALL,BBM` is the same as the following two commands:

```
:ROUT:CONN:RULE ALL,FREE
:ROUT:CONN:SEQ ALL,BBM
```

So, using a semicolon reduces typing and simplifies the program.
A command terminator (such as carriage return) resets the path to root.

Fundamental Commands

The following commands are used to set the fundamental switch control functions of the Agilent B2200. The commands should be entered before performing the open/close operation. For the functions, see “Switch Control Functions” on page 3-12.

Table 4-1 Fundamental Commands

Functions	Commands
Sets the channel configuration mode.	:ROUT:FUNC NCON
	:ROUT:FUNC ACON
Sets the connection rule.	:ROUT:CONN:RULE *card_no*,FREE
	:ROUT:CONN:RULE *card_no*,SROU
Sets the connection sequence.	:ROUT:CONN:SEQ *card_no*,NSEQ
	:ROUT:CONN:SEQ *card_no*,BBM
	:ROUT:CONN:SEQ *card_no*,MBBR

Switch Control

The following commands are used to control open/close of the specified switch.

Table 4-2 **Switch Control Commands**

Functions	Commands
Closes the relays specified by *channel_list*.	`:ROUT:CLOS` *`channel_list`*
Opens the relays specified by *channel_list*.	`:ROUT:OPEN` *`channel_list`*
Opens the all relays on the card specified by *card_no*.	`:ROUT:OPEN:CARD` *`card_no`*

The *channel_list* is the parameter which determines the input-output cross points to open/close. Figure 4-1 shows the basic syntax of the *channel_list* parameter.

In the *channel_list*, you can specify one or more channels. Each specified channel consists of five digits.

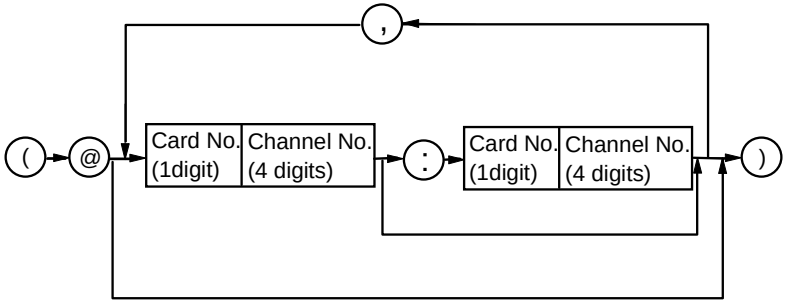
Card No.: One digit. 0 when the channel configuration mode is AUTO. Or the slot number (1 to 4) that installs the switch module when the mode is NORMAL.

Channel No.: First two digits: specifies input port. 01 to 14.

Last two digits: specifies output port. 01 to 12, 01 to 24, 01 to 36, or 01 to 48 for the AUTO mode. It depends on the number of modules installed in the mainframe from slot number 1 continuously. Or 01 to 12 for the NORMAL mode

See Figure 1-4.

Figure 4-1 **Syntax of *channel_list* Parameter**



In the *channel_list*, you can specify multiple channels by using comma (,) or colon (:) as follows:

Comma: use between each specified channel as in following examples:

- `(@10101,10102,10103)` means 10101, 10102 and 10103.
- `(@10112,10202)` means 10112 and 10202.
- `(@11412,20102)` means 11412 and 20102.

Colon: use to specify a range of channels as in following examples:

- `(@10101:10103)` means 10101, 10102, and 10103.
- `(@10112:10202)` means 10112, 10201, and 10202.
- `(@11412:20102)` means 11412, 20101, and 20102.

As shown in last two examples, you can specify a range across input ports and card slots.

NOTE Channel numbers for Auto configuration mode

In the Auto Configuration mode, you can omit any zeros at beginning of channel. For example, channel 00101 can be expressed by 101.

NOTE When Kelvin cables are connected to Outputs

For the Kelvin outputs, the input-output paths must be controlled as shown below.

- For the input couple port:

  Control the switches to connect the input couple port to the Kelvin output.

- For the single input port:

  Control the switches to connect the input port to two ports of the Kelvin output.

If you do not comply with this note, leakage current between the Kelvin paths will cause measurement error.

Programming Examples

This section provides examples of control programs for the Agilent B2200.

- “Connecting Input-Output Paths”
- “Using Bias Mode”
- “Using Ground Mode”
- “Using Couple Mode”
- “Saving Input/Output Labels”
- “Defining Comment for Internal Memory”

NOTE

Executing the program

Example programs use the Microsoft Visual Basic .NET and the Agilent T&M Programmers Toolkit.

The program examples do not include instrument control routines, so to make a measurement, you need to add the desired routines.

NOTE

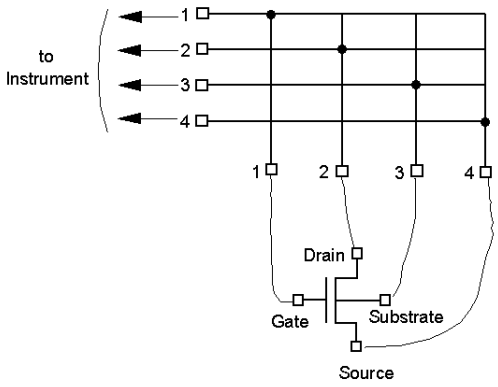
Input port 12 (AUX Input 12)

If you assign the input port 12 to the ground port, the input port 12 will be connected to the ground internally when the ground mode is ON. In this case, leave open the input port 12.

Connecting Input-Output Paths

The following example connects instrument output to DUT as shown in Figure 4-2.

Figure 4-2 **Input-Output Connection Example**



Setup:

- Channel configuration mode: Normal
- Connection rule: Single
- Connection sequence: Break_Before_Make
- Display strings: “Connecting MOSFET AG002201”
- Used module: Switch module installed in the slot 1.
- Connection paths:

  from SMU1 to Output 1 (channel list 10101)

  from SMU2 to Output 2 (channel list 10202)

  from SMU3 to Output 3 (channel list 10303)

  from SMU4 to Output 4 (channel list 10404)

Table 4-3 Input-Output Connection Example

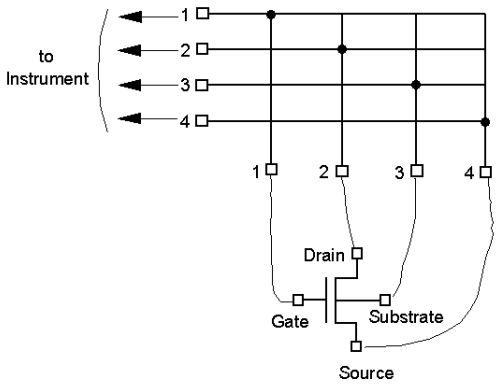
```
Imports Agilent.TMFramework                                              '1
Imports Agilent.TMFramework.InstrumentIO

Module Module1
 Sub Main()
  Dim B2200 As New DirectIO("GPIB0::22::INSTR")                          '6
  Dim channels As String = "(@10101,10202,10303,10404)"
  B2200.WriteLine("*RST")                                                '8
  B2200.WriteLine(":ROUT:FUNC NCON")
  B2200.WriteLine(":ROUT:CONN:RULE ALL,SROU")
  B2200.WriteLine(":ROUT:CONN:SEQ ALL,BBM")
  B2200.WriteLine(":SYST:DISP:STR 'Connecting MOSFET AG002201'")
  B2200.WriteLine(":ROUT:CLOS " & channels)                              '13
  MsgBox("Click OK to start measurement.", vbOKOnly, "")
  Console.WriteLine("Measurement in progress. . ." & Chr(10))
 'insert the code for measurement
  B2200.WriteLine(":ROUT:OPEN:CARD ALL")                                 '17
  B2200.Close()
  MsgBox("Click OK to stop the program.", vbOKOnly, "")
  Console.WriteLine("Measurement completed." & Chr(10))
 End Sub                                                                 '21
End Module
```

Line	Description
1 to 6	The above example is for the B2200 of the GPIB address 22 on the interface GPIB0. “GPIB0” is the VISA name. Confirm your GPIB settings, and set them properly.
7	Defines the channel list in the *channels* variable (string).
8 to 12	Resets the Agilent B2200, sets the Normal configuration mode, the Single connection rule, and the Break_Before_Make connection sequence. And displays the string on the LCD.
13	Closes switches to connect the input-output paths specified by *channels*.
14 to 16	Opens a message box to confirm the start of measurement. And clicking OK on the message box displays a message on the console window. Insert measurement control program code at the line 16.
17	Opens all relays on the all modules installed in the Agilent B2200.
18 to 22	Disables the software connection with the Agilent B2200, and opens a message box to confirm the end of the program. Finally, clicking OK on the message box displays a message on the console window.

Using Bias Mode

The following example uses the bias mode.

Figure 4-3 **Bias Mode Example**



Setup:

- Channel configuration mode: Auto
- Connection rule: Single. Multiple connection is available for the bias port.
- Connection sequence: Break_Before_Make
- Used module: All switch modules installed in the mainframe.
- Bias port: AUX Input 10
- Bias enabled output port: All output ports
- Connection paths (connected when the bias mode is ON):

  from bias port to all bias enabled output ports
- Connection paths (connected by the :ROUT:CLOS command):

  The following output ports will be disconnected from the bias port, and the following input-output connections will be made.

  from SMU1 to Output 1 (channel list 00101)

  from SMU2 to Output 2 (channel list 00202)

  from SMU3 to Output 3 (channel list 00303)

  from SMU4 to Output 4 (channel list 00404)

Table 4-4 Bias Mode Example

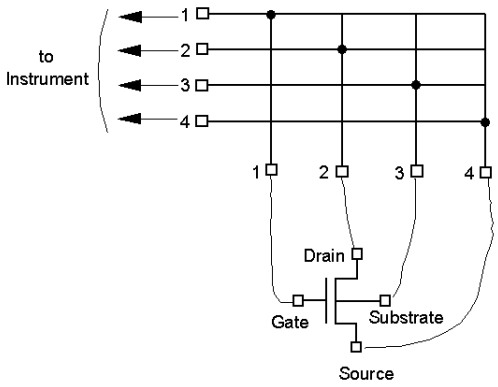
```
Imports Agilent.TMFramework
Imports Agilent.TMFramework.DataAnalysis
Imports Agilent.TMFramework.DataVisualization
Imports Agilent.TMFramework.InstrumentIO
Module Module1
 Sub Main()
  Dim B2200 As New DirectIO("GPIB0::22::INSTR")
  Dim channels As String = "(@101,202,303,404)"                    '8
  B2200.WriteLine("*RST")
  B2200.WriteLine(":ROUT:FUNC ACON")                               '10
  B2200.WriteLine(":ROUT:CONN:RULE ALL,SROU")
  B2200.WriteLine(":ROUT:CONN:SEQ ALL,BBM")
  B2200.WriteLine(":ROUT:BIAS:PORT ALL,10")
  B2200.WriteLine(":ROUT:BIAS:CHAN:ENAB:CARD ALL")
  B2200.WriteLine(":ROUT:BIAS:STAT ALL,ON")
  MsgBox("Click OK to start stress output.", vbOKOnly, "")         '16
 'insert the code for stress output
  B2200.WriteLine(":ROUT:BIAS:STAT ALL,OFF")
  B2200.WriteLine(":ROUT:CLOS " & channels)                        '19
  MsgBox("Click OK to start measurement.", vbOKOnly, "")
  Console.WriteLine("Measurement in progress. . ." & Chr(10))
 'insert the code for measurement
  B2200.WriteLine(":ROUT:OPEN:CARD ALL")
  B2200.Close()
  MsgBox("Click OK to stop the program.", vbOKOnly, "")
  Console.WriteLine("Measurement completed." & Chr(10))
 End Sub                                                           '27
End Module
```

Line	Description
8	Defines the channel list in the *channels* variable (string).
9 to 12	Resets the Agilent B2200. And sets the Auto configuration mode, the Single connection rule, and the Break_Before_Make connection sequence.
13 to 15	Sets the bias port and the bias enabled output ports. And turns the bias mode ON.
16 to 17	Opens a message box to confirm the start of measurement. And clicking OK on the message box displays a message on the console window. Insert bias source control program code at the line 17.
18	Turns the bias mode OFF.
19 to 28	Same as the code shown in the lines 13 to 22 of Table 4-3.

Using Ground Mode

The following example uses the ground mode.

Figure 4-4 **Ground Mode Example**



Setup:

- Channel configuration mode: Auto
- Connection rule: Single. Multiple connection is available for the ground port.
- Connection sequence: Break_Before_Make
- Used module: All switch modules installed in the mainframe.
- Ground port: AUX Input 12
- Ground enabled input port: SMU Input 5 to 8
- Ground enabled output port: All output ports
- Connection paths (connected when the ground mode is ON):

  from ground port to all ground enabled input/output ports
- Connection paths (connected by the :ROUT:CLOS command):

  The following output ports will be disconnected from the ground port, and the following input-output connections will be made.

  from SMU1 to Output 1 (channel list 00101)

  from SMU2 to Output 2 (channel list 00202)

  from SMU3 to Output 3 (channel list 00303)

  from SMU4 to Output 4 (channel list 00404)

Table 4-5 Ground Mode Example

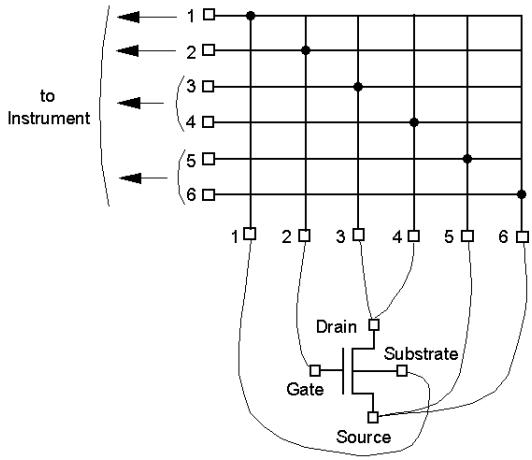
```
Imports Agilent.TMFramework
Imports Agilent.TMFramework.DataAnalysis
Imports Agilent.TMFramework.DataVisualization
Imports Agilent.TMFramework.InstrumentIO
Module Module1
 Sub Main()
  Dim B2200 As New DirectIO("GPIB0::22::INSTR")
  Dim channels As String = "(@101,202,303,404)"                    '8
  B2200.WriteLine("*RST")
  B2200.WriteLine(":ROUT:FUNC ACON")                               '10
  B2200.WriteLine(":ROUT:CONN:RULE ALL,SROU")
  B2200.WriteLine(":ROUT:CONN:SEQ ALL,BBM")
  B2200.WriteLine(":ROUT:AGND:PORT ALL,12")                        '13
  B2200.WriteLine(":ROUT:AGND:UNUSED ALL,'5,6,7,8'")
  B2200.WriteLine(":ROUT:AGND:CHAN:ENAB:CARD ALL")
  B2200.WriteLine(":ROUT:AGND:STAT ALL,ON")
  B2200.WriteLine(":ROUT:CLOS " & channels)                        '17
  MsgBox("Click OK to start measurement.", vbOKOnly, "")
  Console.WriteLine("Measurement in progress. . ." & Chr(10))
 'insert the code for measurement
  B2200.WriteLine(":ROUT:AGND:STAT ALL,OFF")                       '21
  B2200.WriteLine(":ROUT:OPEN:CARD ALL")
  B2200.Close()
  MsgBox("Click OK to stop the program.", vbOKOnly, "")
  Console.WriteLine("Measurement completed." & Chr(10))
 End Sub                                                           '26
End Module
```

Line	Description
8	Defines the channel list in the *channels* variable (string).
9 to 12	Resets the Agilent B2200. And sets the Auto configuration mode, the Single connection rule, and the Break_Before_Make connection sequence.
13 to 16	Sets the ground port and the ground enabled input/output ports. And turns the ground mode ON. Open the ground enabled input ports to prevent the instruments from damage.
17	Closes switches to connect the input-output paths specified by *channels*.
17 to 27	Almost same as the code shown in the lines 13 to 22 of Table 4-3. The command used to turn the ground mode OFF has been inserted to the line 21.

Using Couple Mode

The following example uses the couple mode.

Figure 4-5 **Couple Mode Example**



Setup:

- Channel configuration mode: Auto
- Connection rule: Single
- Connection sequence: Break_Before_Make
- Used module: All switch modules installed in the mainframe.
- Couple port: SMU Input 3-4 and 5-6
- Connection paths:

  from SMU1 to Output 1 (channel list 00101)

  from SMU2 to Output 2 (channel list 00202)

  from SMU3 to Output 3 (channel list 00303)

  from SMU4 to Output 4 (coupled with the channel list 00303)

  from SMU5 to Output 5 (channel list 00505)

  from SMU6 to Output 6 (coupled with the channel list 00505)

Table 4-6 Couple Mode Example

```
Imports Agilent.TMFramework
Imports Agilent.TMFramework.DataAnalysis
Imports Agilent.TMFramework.DataVisualization
Imports Agilent.TMFramework.InstrumentIO
Module Module1
 Sub Main()
  Dim B2200 As New DirectIO("GPIB0::22::INSTR")
  Dim channels As String = "(@101,202,303,505)"                    '8
  B2200.WriteLine("*RST")
  B2200.WriteLine(":ROUT:FUNC ACON")                               '10
  B2200.WriteLine(":ROUT:CONN:RULE ALL,SROU")
  B2200.WriteLine(":ROUT:CONN:SEQ ALL,BBM")
  B2200.WriteLine(":ROUT:COUP:PORT ALL,'3,5'")                     '13
  B2200.WriteLine(":ROUT:COUP:STAT ALL,ON")
  B2200.WriteLine(":ROUT:CLOS " & channels)                        '15
  MsgBox("Click OK to start measurement.", vbOKOnly, "")
  Console.WriteLine("Measurement in progress. . ." & Chr(10))
 'insert the code for measurement
  B2200.WriteLine(":ROUT:COUP:STAT ALL,OFF")                       '19
  B2200.WriteLine(":ROUT:OPEN:CARD ALL")
  B2200.Close()
  MsgBox("Click OK to stop the program.", vbOKOnly, "")
  Console.WriteLine("Measurement completed." & Chr(10))
 End Sub                                                           '24
End Module
```

Line	Description
8	Defines the channel list in the *channels* variable (string).
9 to 12	Resets the Agilent B2200. And sets the Auto configuration mode, the Single connection rule, and the Break_Before_Make connection sequence.
13 to 14	Sets the couple ports, and turns the couple mode ON.
15	Closes switches to connect the input-output paths specified by *channels*.
15 to 25	Almost same as the code shown in the lines 13 to 22 of Table 4-3. The command used to turn the couple mode OFF has been inserted to the line 19.

Saving Input/Output Labels

You can define labels to use for the input/output ports when you control the switch in the GPIB local mode. The labels are cleared by *RST. So it is recommended to save the labels into the internal memory and define a comment for the memory data. You can see the comment when you load/save the memory data in the GPIB local mode.

Setup:

- Channel configuration mode: Auto
- Label for input 1: SMU1
- Label for input 2: SMU2
- Label for input 3: SMU3
- Label for input 4: UNUSED
- Label for input 5: SMU4-F
- Label for input 6: SMU4-S
- Label for input 7: SMU5-F
- Label for input 8: SMU5-S
- Label for input 9: OPEN
- Label for input 10: BIAS
- Label for input 11: OPEN
- Label for input 12: GROUND
- Label for input 13: CMU-H
- Label for input 14: CMU-L
- Label for output 1: BULK
- Label for output 2: SOURCE
- Label for output 3: GATE
- Label for output 4: DRAIN
- Label for output 5: GROUND
- Comment for memory 1: Port label info

Table 4-7 Label Definition and Data Save Example

```
Imports Agilent.TMFramework
Imports Agilent.TMFramework.InstrumentIO
Module Module1
 Sub Main()
  Dim B2200 As New DirectIO("GPIB0::22::INSTR")
  B2200.WriteLine("*RST")
  B2200.WriteLine(":ROUT:FUNC ACON")
  Console.WriteLine("Starts labeling." & Chr(10))
  B2200.WriteLine(":SYST:DISP:STR 'Updating memory 1 data.'")
  B2200.WriteLine(":ROUT:SYMB:PORT 1,'SMU1  '")                    '10
  B2200.WriteLine(":ROUT:SYMB:PORT 2,'SMU2  '")
  B2200.WriteLine(":ROUT:SYMB:PORT 3,'SMU3  '")
  B2200.WriteLine(":ROUT:SYMB:PORT 4,'UNUSED'")
  B2200.WriteLine(":ROUT:SYMB:PORT 5,'SMU4-F'")
  B2200.WriteLine(":ROUT:SYMB:PORT 6,'SMU4-S'")
  B2200.WriteLine(":ROUT:SYMB:PORT 7,'SMU5-F'")
  B2200.WriteLine(":ROUT:SYMB:PORT 8,'SMU5-S'")
  B2200.WriteLine(":ROUT:SYMB:PORT 9,'OPEN  '")
  B2200.WriteLine(":ROUT:SYMB:PORT 10,'BIAS  '")
  B2200.WriteLine(":ROUT:SYMB:PORT 11,'OPEN  '")
  B2200.WriteLine(":ROUT:SYMB:PORT 12,'GROUND'")
  B2200.WriteLine(":ROUT:SYMB:PORT 13,'CMU-H '")
  B2200.WriteLine(":ROUT:SYMB:PORT 14,'CMU-L '")
  B2200.WriteLine(":ROUT:SYMB:CHAN ALL,1,'BULK  '")
  B2200.WriteLine(":ROUT:SYMB:CHAN ALL,2,'SOURCE'")
  B2200.WriteLine(":ROUT:SYMB:CHAN ALL,3,'GATE  '")
  B2200.WriteLine(":ROUT:SYMB:CHAN ALL,4,'DRAIN '")
  B2200.WriteLine(":ROUT:SYMB:CHAN ALL,5,'GROUND'")                '28
  B2200.WriteLine(":SYST:MEMO:SAVE 1")
  B2200.WriteLine(":SYST:MEMO:COMM 1,'Port label info '")
  B2200.WriteLine(":SYST:DISP:STR 'Memory 1 data was updated.'")
  B2200.Close()
  Console.WriteLine("Labeling completed." & Chr(10))
 End Sub                                                           '34
End Module
```

Line	Description
9, 31	Displays message on the LCD.
10 to 28	Defines labels for the inputs 1 to 14 and the outputs 1 to 5.
29	Saves the switch module setup including the labels into the internal memory 1.
30	Defines the comment “Port label info” for the memory 1.

Defining Comment for Internal Memory

You can define comments for the internal memories. You can see the comment when you load/save the memory data in the GPIB local mode.

Setup:

- Channel configuration mode: Auto
- Comment for memory 1: 1-1,2-2,3-3,5-15
- Comment for memory 2: 1-1,2-2,3-4,5-17
- Comment for memory 3: 1-1,2-2,3-5,5-19
- Comment for memory 4: 1-1,2-2,3-7,5-21
- Comment for memory 5: 1-1,2-2,3-9,5-23
- Comment for memory 6: 10-BIAS
- Comment for memory 7: 12-GROUND
- Comment for memory 8: CMH-10,CML-11

Table 4-8 Memory Comment Definition Example

```
Imports Agilent.TMFramework
Imports Agilent.TMFramework.DataAnalysis
Imports Agilent.TMFramework.DataVisualization
Imports Agilent.TMFramework.InstrumentIO
Module Module1
 Sub Main()
  Dim B2200 As New DirectIO("GPIB0::22::INSTR")
  B2200.WriteLine("*RST")                                              '8
  B2200.WriteLine(":ROUT:FUNC ACON")
  Console.WriteLine("Starts labeling." & Chr(10))
  B2200.WriteLine(":SYST:DISP:STR 'Updating memory comment.'")
  B2200.WriteLine(":SYST:MEMO:COMM 1,'1-1,2-2,3-3,5-15'")              '12
  B2200.WriteLine(":SYST:MEMO:COMM 2,'1-1,2-2,3-4,5-17'")
  B2200.WriteLine(":SYST:MEMO:COMM 3,'1-1,2-2,3-5,5-19'")
  B2200.WriteLine(":SYST:MEMO:COMM 4,'1-1,2-2,5-7,7-21'")
  B2200.WriteLine(":SYST:MEMO:COMM 5,'1-1,2-2,5-9,7-23'")
  B2200.WriteLine(":SYST:MEMO:COMM 6,'10-BIAS         '")
  B2200.WriteLine(":SYST:MEMO:COMM 7,'12-GROUND       '")
  B2200.WriteLine(":SYST:MEMO:COMM 8,'CMH-10,CML-11   '")              '19
  B2200.WriteLine(":SYST:DISP:STR 'Memory comment was updated.'")
  B2200.Close()
  Console.WriteLine("Labeling completed." & Chr(10))
 End Sub                                                               '23
End Module
```

Line	Description
8	Resets the Agilent B2200.
9	Sets the channel configuration mode to Auto.
12 to 19	Defines the comments for the internal memory 1 to 8.

Capacitance Compensation

When the capacitance/conductance measurement is performed through the Agilent B2200, LCR meter measures the capacitance/conductance of the path including a device under test (DUT), matrix switches, extension cables and so on. So, the data measured by the LCR meter is far from the DUT's capacitance/conductance.

The Agilent B2200 VXI*plug&play* driver provides the functions used to compensate the capacitance/conductance measured by the Agilent 4284A LCR meter in the measurement environments described in "Required Conditions" on page 4-21.

This section explains how to use the capacitance compensation function.

- "Capacitance Compensation Function"
- "Required Conditions"
- "To Create Compensation Data File"
- "To Perform Measurement and Compensation"

Capacitance Compensation Function

Driver functions used for the capacitance compensation are listed below.

- agb220xa_selectCompenFile function
- agb220xa_compenC function

NOTE

Corrected data by the function is not guaranteed. But typical data (supplemental data) is as follows.

Capacitance measurement accuracy (typical): ±1 % ±0.5 pF

This typical data is for the following measurement conditions:

Measurement frequency: 1 kHz to 1 MHz

Measurement range: Maximum 1000 pF

Measurement terminal: At the end of the Agilent 16494A/B/C cable connected to the switch module output terminals.

The typical data does not apply to anything extended from the 16494A/B/C cable. The conditions described in "Required Conditions" on page 4-21 must be satisfied.

Required Conditions

The following conditions must be satisfied to use the capacitance compensation function. For the instrument connections, see Figure 4-6.

- Setting of the 4284A
  - Option required: 4284A-006
  - Range of the measurement frequency: 1 kHz to 1 MHz
  - Measurement function: Cp-G
  - Connection to Agilent B2200

    Use the Agilent 16494F CMU cable or the Agilent 16048D/E test leads to connect between the Agilent 4284A and the Agilent B2200 inputs.

    If the 16048D/E is used, the BNC-T adapters (2 ea., Agilent part number 1250-2405 for each) are required to connect between the Hc and Hp terminals and between the Lc and Lp terminals.
  - Calibration

    Perform the 4284A open calibration at the end of the measurement paths in front of the B2200 inputs. If you also perform the short calibration (optional), prepare the BNC thru adapter (Agilent part number 1250-0080, 1 ea.).
  - Total cable length of both Hc-Hp side and Lc-Lp side must be the same.
- Agilent B2200 input ports

  AUX Input 13 (CMH, for 4284A Hc-Hp) and 14 (CML, for 4284A Lc-Lp)
- Connection from the Agilent B2200 outputs to the connector plate or the Agilent B2220A probe card interface

  Use the Agilent 16494A triaxial cable or Agilent 16494B/C Kelvin triaxial cable.
- Ahead of the connector plate

  Recommended cable: Agilent part number 8121-1191 Triaxial cable

  You can also use another type of triaxial cable, coaxial cable, or combination of these.

  To approximate the capacitance/conductance of the DUT, you need to obtain the appropriate compensation coefficients for your measurement environment, and create your compensation data file. See Figure 4-6.

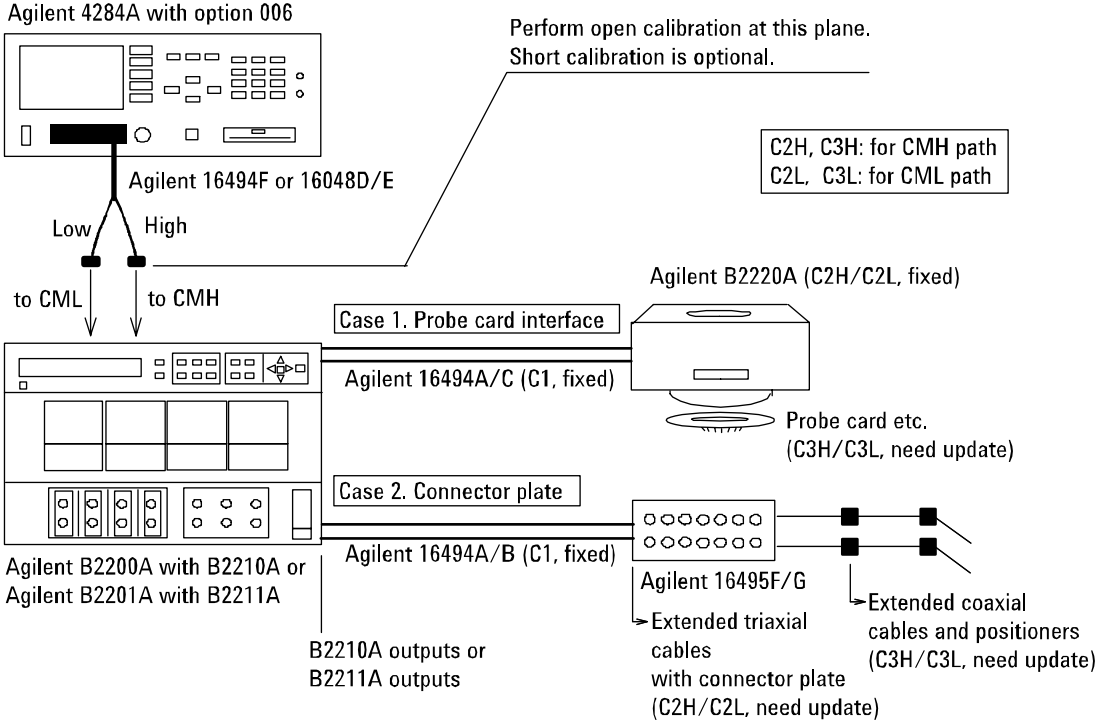
In Figure 4-6, C2H, C2L, C3H, C3L are the compensation coefficients defined in the compensation data file. where, CxH is for the path connected to the Agilent 4284A Hc-Hp terminal, and CxL is for the path connected to the Agilent 4284A Lc-Lp terminal.

When the Agilent B2220A probe card interface is used, obtain the coefficients for C3x, and create your compensation data file. In this case, probe card will be used for the C3x path.

When the connector plate is used, obtain the coefficients for C2x and C3x, and create your compensation data file. In this case, triaxial cable with connector plate will be used for the C2x path. And coaxial cable with positioner will be used for the C3x path.

For obtaining the compensation coefficients and creating the compensation data file, see “To Create Compensation Data File” on page 4-23.

Figure 4-6 Extension Cables and Compensation Coefficients



To Create Compensation Data File

This section explains how to create the compensation data file.

1. Select one of the compensation data files (template, 20 files) installed when the Agilent B2200 VXI*plug&play* driver is installed.

   To select the most appropriate template for your measurement environment, see Table 4-9 that lists the file name and the measurement environment where the template targets. Each template is a text file that contains the information as shown below.

```
#
# Compensation data file for B2210A/Probecard I/F/3m triax cable
#
#
# MB          Mother Board
# MH          Matrix Path High
# ML          Matrix Path Low
# C1          Agilent Triax Cable
# C2H         Probe card I/F or User Triax cable High
# C2L         Probe card I/F or User Triax cable Low
# C3H         Probe card or User Coax cable High
# C3L         Probe card or User Coax cable Low
#
format version 1.0
B2210A
PCIF
#
#           R[Ohm]             L[H]               C[F]
#-----------------------------------------------------------
MB          0.000000e+00       5.250000e-08       2.940000e-11
MH          2.430000e+00       6.310000e-07       1.930000e-10
ML          2.490000e+00       5.970000e-07       1.920000e-10
C1          6.300000e-01       1.250000e-06       1.600000e-10
C2H         2.988000e-01       5.090000e-07       7.000000e-11
C2L         2.988000e-01       5.090000e-07       7.000000e-11
C3H         0.000000e+00       8.000000e-08       1.500000e-13
C3L         0.000000e+00       8.000000e-08       1.500000e-13
```

   The 15th line specifies the used switch module, B2210A or B2211A.

   The 16th line specifies the DUT interface, PCIF or CABLE. PCIF indicates that the Agilent B2220A probe card interface is used. CABLE indicates that the connector plate is used.

   The lines C2H to C3L should be modified for each measurement environment. See Table 4-9 and Table 4-10. Do not modify the other lines.

Table 4-9 Template Compensation Data Files

File name[a]	Measurement environment that template targets			
	Switch module	Cable[b]	DUT interface[c]	Coefficients to be modified
<path>\B2210A\pcif\triax\3m.data	B2210A	16494A-002	B2220A	C3H and C3L
<path>\B2210A\pcif\triax\4m.data		16494A-005		
<path>\B2210A\pcif\kelvin\3m.data		16494C-002		
<path>\B2210A\pcif\kelvin\4m.data		16494C-005		
<path>\B2210A\cable\triax\1_5m.data		16494A-001	16495F/G	C2H, C2L, C3H, and C3L
<path>\B2210A\cable\triax\3m.data		16494A-002		
<path>\B2210A\cable\triax\4m.data		16494A-005		
<path>\B2210A\cable\kelvin\1_5m.data		16494B-001		
<path>\B2210A\cable\kelvin\3m.data		16494B-002		
<path>\B2210A\cable\kelvin\4m.data		16494C-005		
<path>\B2211A\pcif\triax\3m.data	B2211A	16494A-002	B2220A	C3H and C3L
<path>\B2211A\pcif\triax\4m.data		16494A-005		
<path>\B2211A\pcif\kelvin\3m.data		16494C-002		
<path>\B2211A\pcif\kelvin\4m.data		16494C-005		
<path>\B2211A\cable\triax\1_5m.data		16494A-001	16495F/G	C2H, C2L, C3H, and C3L
<path>\B2211A\cable\triax\3m.data		16494A-002		
<path>\B2211A\cable\triax\4m.data		16494A-005		
<path>\B2211A\cable\kelvin\1_5m.data		16494B-001		
<path>\B2211A\cable\kelvin\3m.data		16494B-002		
<path>\B2211A\cable\kelvin\4m.data		16494C-005		

a. <path>: driver_install_folder\AGB220XA\ccdata (e.g. C:\temp\AGB220XA\ccdata)
b. Model number of the cable connected between the switch module and the DUT interface.
c. Agilent B2220A probe card interface or Agilent 16495F/G connector plate.

Table 4-10 Compensation Coefficients and Modifications

Compensation coefficients	Modifications of data file
C2H C2L	For the Agilent B2220A probe card interface, do not modify the lines. For the connector plate, change the R, L, C values in the lines. The value must be changed to the R, L, C values of the C2x path (triaxial cable with connector plate) shown in Figure 4-6.
C3H C3L	Change the R, L, C values in the lines. The value must be changed to the R, L, C values of the C3x path. For the Agilent B2220A probe card interface, probe card will be used for the C3x path. For the connector plate, coaxial cable with positioner will be used for the C3x path.

2. Measure the R, L, C values of the C2x or C3x path by using the Agilent 4284A. See “To obtain compensation coefficients” on page 4-26.

   After the measurements, calculate the per meter value of the R, L, C, and record them into the following table.

Compensation coefficients	Explanation		
	R (Ω)	L (H)	C (F)
C2H			
C2L			
C3H			
C3L			

3. Open the template file selected at step 1 by using a text editor. Exchange the R, L, C values of C2x/C3x with the values recorded at step 2. And save the file as your compensation data file (e.g. C:\temp\my_env_1.txt).

   Do not change any other lines. Also do not change the value for the coefficients that should not be modified.

To obtain compensation coefficients

Obtain the compensation coefficients as shown below.

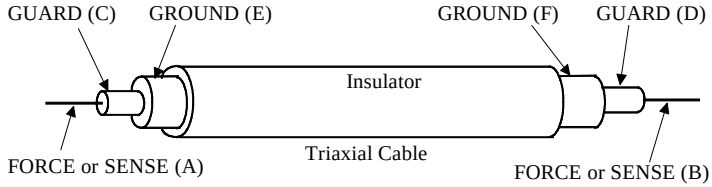
1. Select the measurement frequency (Fmeas) used for the capacitance measurement of a device under test (DUT), and set it to the Agilent 4284A. The coefficients must be measured at the same frequency.
2. Perform the Agilent 4284A open calibration at the measurement terminal. Optionally, perform short calibration if you want.
3. See Table 4-11 and Figure 4-7, and set the Agilent 4284A.
4. Connect the path/cable corresponding to C3H shown in Figure 4-6 to the Agilent 4284A. Then measure and record the R, L, and C values.
5. Connect the path/cable corresponding to C3L to the Agilent 4284A. Then measure and record the R, L, and C values.
6. If you use the connector plate, perform the following procedure.
   a. Connect the path/cable corresponding to C2H to the Agilent 4284A. Then measure and record the R, L, and C values.
   b. Connect the path/cable corresponding to C2L to the Agilent 4284A. Then measure and record the R, L, and C values.

Table 4-11 R, L, C Measurement Conditions

Parameter	Frequency	Function	Terminals
R	1 kHz to 1 MHz [a]	–	A and B
L		SERIES	see note [b]
C		PARALLEL	A and C

a. Select 1 point. Do not change while measurements of all coefficients.
b. For triaxial cable, connect B to F directly, and measure L between A and E. For coaxial cable, connect B to D directly, and measure L between A and C. Ignore E and F.

Figure 4-7 Measurement Terminals of C2H/C2L/C3H/C3L Path



To Perform Measurement and Compensation

Perform the capacitance measurement and compensation as shown below.

1. Set the Agilent 4284A measurement condition. Then the frequency must be the value (Fmeas) used when the compensation coefficients are measured.
2. Before contacting the device under test (DUT), perform the Cp-G measurement in the open condition at the end of the measurement path including positioner or probe card, and record the measurement data (`C1` and `G1`). See Table 4-12.
3. Perform the compensation by using the capacitance compensation function, and record the result data (`C1r` and `G1r`).

   See Table 4-13 for the example to use the capacitance compensation function. This example uses Microsoft Visual Basic .NET and Agilent T&M Programmers Toolkit. And the Agilent B2200 controlled by the program is defined as AGB2200 at the 10th line. So, the function names are changed as shown below.

   agb220xa_selectCompenFile --> Agb2200.SelectCompenFile

   agb220xa_compenC --> Agb2200.CompenC

   Also, agb220xa_reset and agb220xa_close have been changed.
4. Contact the DUT, perform the Cp-G measurement, and record the measurement data (`C2` and `G2`).
5. Perform the compensation and record the result data (`C2r` and `G2r`).
6. Perform the following calculation and record it as the capacitance value.

   ```
   C = C2r - C1r
   ```

Table 4-12 Recording Measurement/Compensation Data

step	Measurement/Compensation Data	
	C (F)	G (S)
2 (measured)	C1 =	G1 =
3 (compensated)	C1r =	G1r =
4 (measured)	C2 =	G2 =
5 (compensated)	C2r =	G2r =
6 (calculated)	C =	

Table 4-13 Capacitance Compensation Program Example

```
Imports Agilent.TMFramework
Imports Agilent.TMFramework.DataAnalysis
Imports Agilent.TMFramework.DataVisualization
Imports Agilent.TMFramework.InstrumentIO
Imports Agilent.TMFramework.InstrumentDriverInterop
Imports Agilent.TMFramework.InstrumentDriverInterop.Design
Imports Agilent.TMFramework.InstrumentDriverInterop.VxipnpWrappers
Module Module1
 Sub Main()                                                              '9
  Dim Agb2200 As Agb220xa = New Agb220xa("GPIB0::22::INSTR", True, True)
  Agb2200.Reset()
  Dim f_com as String = "C:\temp\my_env_1.txt"                           '12
  Agb2200.SelectCompenFile(f_com)

  Dim freq As Double = 1000000             'measurement frequency: 1 (MHz)  15
  Dim data_c As Double = 0.0000000001      'C measured by 4284A: 100 (pF)
  Dim data_g As Double = 0.0005            'G measured by 4284A: 0.5 (mS)
  Dim res_c As Double
  Dim res_g As Double
  Agb2200.CompenC(freq, data_c, data_g, res_c, res_g)                    '20

  Dim result As String = "C = " & res_c * 1000000000000.0 & " (pF)"      '22
  result = result & Chr(10) & "G = " & res_g * 1000 & " (mS)" & Chr(10)
  Console.WriteLine(result)
  Agb2200.Close()
 End Sub
End Module
```

Line	Description
1 to 11	The above example is for the B2200 of the GPIB address 22 on the interface GPIB0. “GPIB0” is the VISA name. Confirm your GPIB settings, and set them properly.
12 to 13	The lines specify the compensation data file. The file name must specify your compensation data file.
15 to 20	Compensates the data measured by the Agilent 4284A. In this example, the measurement frequency is 1 MHz, the capacitance data is 100 pF, and the conductance data is 0.5 mS. Change freq, data_c, data_g values for your measurement results.
22 to 24	Displays the compensation result data on the console window. Record the values as C1r and G1r, or C2r and G2r.

5 SCPI Command Reference

This chapter describes the following for Agilent B2200:

- SCPI commands available to control the B2200 via GPIB interface.

  SCPI is a universal programming language for electronic test and measurement instruments, and is based on IEEE 488.1 and IEEE 488.2.

  SCPI commands are divided into two types: *common commands* and *subsystem commands*.

  Common commands are generally not measurement related, but are used to manage status registers, data storage, and so on. Common commands are defined by IEEE 488.2. All common commands begin with an asterisk, such as *RST.

  Subsystem commands are mostly measurement related and some are general purpose. Subsystem commands have a hierarchical structure that uses a colon between mnemonics (keywords), such as `:DIAG:TEST:CARD:CLE`.

  Commands for the following subsystems are available for the B2200:

  DIAGnostic commands for performing self-test.

  ROUTe commands for signal routing.

  SYSTem commands for controlling other functions that are not related to instrument performance.

  Commands are listed in alphabetical order in this chapter.

- Status reporting structure

  These are IEEE 488.2 status structures (registers), which can be set or read by the common commands.

Textual Notation for Subsystem Commands

CAPITAL LETTERS	Capital letters are the minimally required letters of the command header. Lowercase letters are the long form (complete spelling), which you can omit if desired. For example, for :SYSTem:CCONfig?, you only need to specify :SYST:CCON?.
[ ]	Square brackets are used to enclose optional information not required for execution of the command sequence. For example, for the [:ROUTe]:BIAS:PORT command, you can execute :ROUT:BIAS:PORT or :BIAS:PORT, which are exactly the same.
italic font	Text you supply. For example, for *card_number*, you enter an allowed card number. Also, used to represent response data.
|	Vertical bar can be read as “or” and is used to separate alternative parameter options.
{ }	Braces (curly brackets) are used to enclose one or more parameters that may be included zero or more times.
< >	Angular brackets indicate that the word or words enclosed represent something other than themselves. For example, <`newline`>.

Common Commands

This section describes common commands and queries, which are commands defined by *IEEE 488.2*.

Commands Summary

The following table shows some common commands that are supported for the B2200.

Mnemonic	Name
*CLS	Clear Status
*ESE(?)	Standard Event Status Enable Command (Query)
*ESR?	Standard Event Status Register Query
*IDN?	Identification Query
*OPC(?)	Operation Complete Command (Query)
*RST	Reset Command
*SRE(?)	Service Request Enable Command (Query)
*STB?	Read Status Byte Query
*TST?	Self-Test Query
*WAI	Wait-to-Continue Command

*CLS

This command clears the Status Byte Register, the Standard Event Status Register, and the Error Queue. This command does *not* clear the enable registers. See “Status Reporting Structure” on page 5-53.

Also, this command stops the monitoring of pending operations by the *OPC command.

This command does not have query form.

Syntax

```
*CLS
```

Example

```
OUTPUT @Agb2200;"*CLS"
```

*ESE

This command sets the bits of the Standard Event Status “Enable” Register. `1` enables, `0` masks.

Syntax

`*ESE` *enable_number*

Parameter	Explanation
enable_number	decimal integer (that is the sum of the binary-weighted values for the desired bits), hexadecimal, octal, or binary value

Query response

enable_number <newline><^END>

enable_number is decimal integer value that is the sum of the binary-weighted values of the “Enable” register bits.

Semantics

The Standard Event Status “Enable” Register determines which bits of the Standard Event Status Register are enabled. Enabled bits are ORed together, and the result is reported to bit5 of the Status Byte Register.

The Standard Event Status “Enable” Register consists of 16 bits, but only the lower 8 bits are used, which correspond to the bits of the Standard Event Status Register. For details, see “Standard Event Status Enable Register” on page 5-59.

The following table shows the bits of the Standard Event Status Register and binary-weighted *decimal* value of each bit.

bit	binary-weight	description
0	1	OPC (Operation Complete)
1	2	not used
2	4	QYE (Query ERROR)
3	8	DDE (Device-Dependent ERROR)
4	16	EXE (Execution ERROR)
5	32	CME (Command ERROR)
6	64	not used
7	128	PON (Power on)

Example

The following four lines enable the same bit (CME bit):

```
OUTPUT @Agb2200;"*ESE 32"            using decimal numeric
OUTPUT @Agb2200;"*ESE #B100000"      using binary numeric
OUTPUT @Agb2200;"*ESE #Q40"          using octal numeric
OUTPUT @Agb2200;"*ESE #H20"          using hexadecimal numeric
```

The following is example for query:

```
OUTPUT @Agb2200;"*ESE?"
ENTER @Agb2200;A
```

*ESR?

This query command returns the present contents of the Standard Event Status Register.

Syntax

*ESR?

Query response

register <newline><^END>

Parameter	Explanation
register	decimal integer value that is the sum of the binary-weighted values for the set bits

Semantics

The following table shows the bits of the Standard Event Status Register, and the binary-weighted *decimal* value of each bit.

bit	binary-weight	description
0	1	OPC (Operation Complete)
1	2	not used. always 0.
2	4	QYE (Query ERROR)
3	8	DDE (Device-Dependent ERROR)
4	16	EXE (Execution ERROR)
5	32	CME (Command ERROR)
6	64	not used. always 0.
7	128	PON (Power on)

Example

```
OUTPUT @Agb2200;"*ESR?"
ENTER @Agb2200;A
```

*IDN?

This query command returns the ID of your B2200.

Syntax

```
*IDN?
```

Query response

`AGILENT,`*model*`,0,`*revision* <newline><^END>

Response	Type	Explanation
model	character	model number. `B2200A` or `B2201A`
revision	character	revision number. `A.01.00` or later

Example

```
DIM A$[50]
OUTPUT @Agb2200;"*IDN?"
ENTER @Agb2200;A$
PRINT A$
```

An example result of above program is:

```
AGILENT,B2200A,0,A.01.00
```

*OPC

This command starts to monitor pending operations, and sets/clears the Operation Complete (OPC) bit in the Standard Event Status Register as follows:

- If there is no pending operation, sets the OPC bit to 1.
- If there are any pending operations, sets the OPC bit to 0. The bit will be set to 1 again when all pending operations are completed.

So, *OPC command is required to enable the OPC bit. To stop monitoring pending operations (disable OPC bit), execute the *CLS command.

For details about the Standard Event Status Register, see “Standard Event Status Register” on page 5-58. Also, see *WAI command.

Syntax

```
*OPC
```

Query response

1 <newline><^END>

`*OPC?` places ASCII character `1` into the Output Queue when all pending operations are completed. For details, see “Output Queue” on page 5-60.

Example

```
OUTPUT @Agb2200;"*OPC"
```

The following example is for query:

```
OUTPUT @Agb2200;"*OPC?"
ENTER @Agb2200;A
```

*RST

This command performs an instrument reset. Status after *RST is shown below:

Channel Configuration:	Auto configuration mode
Connection Rule:	Free
Connection Sequence:	Break Before Make
Bias Mode:	Off
Bias Input Port:	10
Bias-enabled Channels:	All channels (output ports) are bias-enabled.
Couple Mode:	Off
Couple Input Port:	Cleared.
Ground Mode:	Off
Ground Input Port:	12
Ground-enabled Channels:	Cleared.
Ground-enabled Ports:	Cleared.
Card Channel Status:	All relays are opened.
Self-Test Result:	Not changed.
Input Port Symbol String:	Cleared.
Output Port Symbol String:	Cleared.
Beeper:	On
LCD in remote mode:	Off
LED in remote mode:	On
Light Pen:	Enabled.

Syntax

```
*RST
```

Example

```
OUTPUT @Agb2200;"*RST"
```

NOTE

This command does not change the self-test result.

For the power-on settings, see :SYSTem:CPON.

*SRE

This command sets the Service Request “Enable” Register bits.
`1` enables, `0` masks.

Syntax

`*SRE` *enable_number*

Parameter	Explanation
enable_number	decimal integer (that is the sum of the binary-weighted values for the desired bits), hexadecimal, octal, or binary value

Query response

enable_number <newline><^END>

Semantics

The Service Request “Enable” Register consists of 8 bits: Bit0 to Bit7. Bit6 is not defined, and is always `0`. The Service Request “Enable” Register determines which bits of the Status Byte Register are enabled.

The status of the enabled bits are ORed together, and the result of OR is output to bit6 (Master Summary Status bit) of Status Byte Register. For details, see “Status Reporting Structure” on page 5-53.

The following table shows the bits of the Status Byte Register, and the binary-weighted *decimal* value of each bit.

bit	binary-weight	description
0	1	not used
1	2	not used
2	4	not used
3	8	not used
4	16	MAV (Message Available summary-message)
5	32	ESB (Event Status Bit)
6	64	MSS (Master Summary Status)
7	128	not used

Example

The following four lines enable the same bits (bit 4 and 5):

```
OUTPUT @Agb2200;"*SRE 48"          using decimal numeric
OUTPUT @Agb2200;"*SRE #B110000"    using binary numeric
OUTPUT @Agb2200;"*SRE #Q60"        using octal numeric
OUTPUT @Agb2200;"*SRE #H30"        using hexadecimal numeric
```

The following is example for query:

```
OUTPUT @Agb2200;"*SRE?"
ENTER @Agb2200;A
```

*STB?

This query command reads the Status Byte Register (reads Master Summary Status bit, not Request for Service Message).

For bit6, this command reads MSS, not Request for Service (RQS). See “Status Reporting Structure” on page 5-53.

Syntax

```
*STB?
```

Query response

register <newline><^END>

Parameter	Explanation
register	decimal integer value that is the sum of the binary-weighted values for the set bits

Semantics

The following table shows the bits of the Status Byte Register, and the binary-weighted *decimal* value of each bit.

bit	binary-weight	description
0	1	not used. always 0.
1	2	not used. always 0.
2	4	not used. always 0.
3	8	not used. always 0.
4	16	MAV (Message Available summary-message)
5	32	ESB (Event Status Bit)
6	64	MSS (Master Summary Status)
7	128	not used. always 0.

Example

```
OUTPUT @Agb2200;"*STB?"
ENTER @Agb2200;A
```

*TST?

This query command executes an internal self-test, then returns the result. After this command execution, the B2200 becomes same status as after *RST command execution.

Syntax `*TST?`

Query response *test_result* <newline><^END>

test_result	Explanation
0	pass
1	fail

Example

```
OUTPUT @Agb2200;"*TST?"
ENTER @Agb2200;A
```

*WAI

This command stops execution of any commands until the Operation Complete (OPC) bit is set to 1, which means there is no pending operation. See *OPC command.

Syntax `*WAI`

Example

```
OUTPUT @Agb2200;"*WAI"
```

Subsystem Commands

Command Summary

ROUT subsystem

:ROUTe subsystem has commands for controlling the signal routing.

"**Open a channel**": opens relays to disconnect the channel (that is, disconnects input port from output port).

"**Close a channel**": closes relays to connect the channel (that is, connects input port to output port).

Command	Description
`[:ROUT]:FUNC` *channel_config* `[:ROUT]:FUNC?`	Sets the channel configuration mode. *channel_config*: `ACON`: Auto Config Mode `NCON`: Normal Config Mode Query returns the present channel configuration: `ACON` or `NCON`.
`[:ROUT]:CONN:RULE` *card_number*`,`*rule* `[:ROUT]:CONN:RULE?` *card_number*	Sets the connection rule for the specified card. *card_number*: `0` or `ALL` for Auto Config, `1`, `2`, `3`, `4`, or `ALL` for Normal Config *rule*: `FREE` (free) or `SROUte` (single) Query returns the connection rule of the specified card: `FREE` or `SROU`. *card_number*: Card to check. `0` for Auto Config, `1`, `2`, `3`, or `4` for Normal Config.
`[:ROUT]:CONN:SEQ` *card_number*`,`*sequence* `[:ROUT]:CONN:SEQ?` *card_number*	Specifies the connection sequence mode for the specified card. *card_number*: `0` or `ALL` for Auto Config, `1`, `2`, `3`, `4`, or `ALL` for Normal Config *sequence*: `NSEQ`: No-Sequence mode `BBM`: Break-Before-Make mode `MBBR`: Make-Before-Break mode Query returns the connections sequence mode of the specified card: `NSEQ`, `BBM`, or `MBBR`. *card_number*: Card to check. `0` for Auto Config, `1`, `2`, `3`, or `4` for Normal Config.

Command	Description
[:ROUT]:SYMB:CHAN *card_number*,*channel*,'*string*' [:ROUT]:SYMB:CHAN? *card_number*,*channel*	Defines a string for the specified channel. *card_number*: 0 or ALL for Auto Config, 1, 2, 3, 4, or ALL for Normal Config *channel*: channel number, 1 to 48 for Auto, 1 to 12 for Normal Query returns the symbol string set to the specified channel.
[:ROUT]:SYMB:PORT *port*,'*string*' [:ROUT]:SYMB:PORT? *port*	Defines a string for the specified input port. *port*: input port number, 1 to 14 Query returns the symbol string set to the specified input port.
Relay Control Commands	
[:ROUT]:OPEN:CARD *card_number*	Disconnects all input ports from all output ports for the specified card. *card_number*: 0 or ALL for Auto Config, 1, 2, 3, 4, or ALL for Normal Config
[:ROUT]:OPEN[:LIST] (@*channel_list*) [:ROUT]:OPEN[:LIST]? (@*channel_list*)	Disconnects the input ports from output ports as specified in *channel_list*. *channel_list*: Channels to open. Query returns the status of the specified channels: 0 (closed) or 1 (opened). *channel_list*: Channels to check.
[:ROUT]:CLOS:CARD? *card_number*	Returns *channel_list* of all closed channels for the specified card. “closed channel” means an input port connected to an output port. *card_number*: Card to check. 0 for Auto Config, 1, 2, 3, or 4 for Normal Config.
[:ROUT]:CLOS[:LIST] (@*channel_list*) [:ROUT]:CLOS[:LIST]? (@*channel_list*)	Connects the input ports to the output ports as specified in *channel_list*. *channel_list*: Channels to close. Query returns the status of the specified channels: 1 (closed) or 0 (opened). *channel_list*: Channels to check.

Command	Description
Bias Mode Commands	
[:ROUT]:BIAS:CHAN:DIS:CARD *card_number*	Bias-disables the specified card. *card_number*: 0 or ALL for Auto Config, 1, 2, 3, 4, or ALL for Normal Config
[:ROUT]:BIAS:CHAN:DIS[:LIST] (@*channel_list*) [:ROUT]:BIAS:CHAN:DIS[:LIST]? (@*channel_list*)	Bias-disables the specified channels. *channel_list*: Channels to bias-disable. Query returns the status of the specified channels: 1 (disabled) or 0 (enabled). *channel_list*: Channels to check.
[:ROUT]:BIAS:CHAN:ENAB:CARD *card_number*	Bias-enables the specified card. *card_number*: 0 or ALL for Auto Config, 1, 2, 3, 4, or ALL for Normal Config
[:ROUT]:BIAS:CHAN:ENAB[:LIST] (@*channel_list*) [:ROUT]:BIAS:CHAN:ENAB[:LIST]? (@*channel_list*)	Bias-enables the specified channels. *channel_list*: Channels to bias-enable. Query returns the status of the specified channels: 1 (enabled) or 0 (disabled). *channel_list*: Channels to check.
[:ROUT]:BIAS:PORT *card_number*,*bias_port* [:ROUT]:BIAS:PORT? *card_number*	Specifies the input Bias Port for the specified card. *card_number*: 0 or ALL for Auto Config, 1, 2, 3, 4, or ALL for Normal Config *bias_port*: 1 to 14 or -1 Query returns the input Bias Port number for the specified card. *card_number*: Card to check. 0 for Auto Config, 1, 2, 3, or 4 for Normal Config.
[:ROUT]:BIAS[:STAT] *card_number*,*state* [:ROUT]:BIAS[:STAT]? *card_number*	Sets the bias mode for the specified card. *card_number*: 0 or ALL for Auto Config, 1, 2, 3, 4, or ALL for Normal Config *state*: ON / 1 (mode ON) or OFF / 0 (mode OFF) Query returns the mode status of the specified card: 0 (OFF) or 1 (ON). *card_number*: Card to check. 0 for Auto Config, 1, 2, 3, or 4 for Normal Config.

Command	Description
Ground Mode Commands	
`[:ROUT]:AGND:CHAN:DIS:CARD` *card_number*	Ground-disables the specified card. *card_number*: `0` or `ALL` for Auto Config, `1`, `2`, `3`, `4`, or `ALL` for Normal Config
`[:ROUT]:AGND:CHAN:DIS[:LIST]` (`@`*channel_list*) `[:ROUT]:AGND:CHAN:DIS[:LIST]?` (`@`*channel_list*)	Ground-disables the specified channels. *channel_list*: Channels to ground-disable. Query returns the status of the specified channels: `1` (disabled) or `0` (enabled). *channel_list*: Channels to check.
`[:ROUT]:AGND:CHAN:ENAB:CARD` *card_number*	Ground-enables the specified card. *card_number*: `0` or `ALL` for Auto Config, `1`, `2`, `3`, `4`, or `ALL` for Normal Config
`[:ROUT]:AGND:CHAN:ENAB[:LIST]` (`@`*channel_list*) `[:ROUT]:AGND:CHAN:ENAB[:LIST]?` (`@`*channel_list*)	Ground-enables the specified channels. *channel_list*: Channels to ground-enable. Query returns the status of the specified channels: `1` (enabled) or `0` (disabled). *channel_list*: Channels to check.
`[:ROUT]:AGND:PORT` *card_number*`,`*ground_port* `[:ROUT]:AGND:PORT?` *card_number*	Specifies the input Ground Port for the specified card. *card_number*: `0` or `ALL` for Auto Config, `1`, `2`, `3`, `4`, or `ALL` for Normal Config *ground_port*: `1` to `14` or `-1` Query returns the input Ground Port number for the specified card. *card_number*: Card to check. `0` for Auto Config, `1`, `2`, `3`, or `4` for Normal Config.
`[:ROUT]:AGND[:STAT]` *card_number*`,`*state* `[:ROUT]:AGND[:STAT]?` *card_number*	Sets the ground mode for the specified card. *card_number*: `0` or `ALL` for Auto Config, `1`, `2`, `3`, `4`, or `ALL` for Normal Config *state*: `ON` / `1` (mode ON) or `OFF` / `0` (mode OFF) Query returns the mode status of the specified card: `0` (OFF) or `1` (ON). *card_number*: Card to check. `0` for Auto Config, `1`, `2`, `3`, or `4` for Normal Config.

Command	Description
[:ROUT]:AGND:UNUSED *card_number*,'*enable_port*' [:ROUT]:AGND:UNUSED? *card_number*	Ground-enables the specified input ports for the specified card. *card_number*: 0 or ALL for Auto Config, 1, 2, 3, 4, or ALL for Normal Config *enable_port*: One or more input port numbers: 1 to 8. Enclose by single quotation marks. Separate multiple input port numbers by comma. For example: '1,5' Query returns the ground-enabled input port numbers for the specified card. *card_number*: Card to check. 0 for Auto Config, 1, 2, 3, or 4 for Normal Config.
Couple Mode Commands	
[:ROUT]:COUP:PORT *card_number*,'*couple_port*' [:ROUT]:COUP:PORT? *card_number*	Specifies the input couple ports for the specified card. *card_number*: 0 or ALL for Auto Config, 1, 2, 3, 4, or ALL for Normal Config *couple_port*: One or more input port numbers: 1, 3, 5, 7, 9, 11, or 13. Enclose by single quotation marks. Separate multiple input port numbers by comma. For example: '1,5' Query returns the lower input port number of each couple pair for the specified card. *card_number*: Card to check. 0 for Auto Config, 1, 2, 3, or 4 for Normal Config.
[:ROUT]:COUP:PORT:DET	Detects the input ports connected to Kelvin cable, and assigns them as the input couple ports for the all cards.
[:ROUT]:COUP[:STAT] *card_number*,*state* [:ROUT]:COUP[:STAT]? *card_number*	Sets the couple mode for the specified card. *card_number*: 0 or ALL for Auto Config, 1, 2, 3, 4, or ALL for Normal Config *state*: ON / 1 (mode ON) or OFF / 0 (mode OFF) Query returns the mode status of the specified card: 0 (OFF) or 1 (ON). *card_number*: Card to check. 0 for Auto Config, 1, 2, 3, or 4 for Normal Config.

DIAG subsystem

:DIAGnostic subsystem has commands for executing the self-test function. For more info, see “Selftest Menu” on page 3-34.

The :DIAGnostic subsystem commands ignore the B2200 channel configuration mode. For :DIAG commands that require a card number, you specify `1`, `2`, `3`, `4`, or `ALL`.

Command	Description
`:DIAG:TEST:CARD:CLE` *card_number*	Clears relay test result (pass/fail) of the specified card. *card_number*: `1`, `2`, `3`, `4`, or `ALL`
`:DIAG:TEST:CARD[:EXEC]?` *card_number*	Executes relay test, then returns result: `1` (fail card exists), `0` (pass). *card_number*: `1`, `2`, `3`, `4`, or `ALL`
`:DIAG:TEST:CARD:STAT?` *card_number*	Returns most recent relay test result: `1` (fail), `0` (pass), `-1` (not tested). *card_number*: `1`, `2`, `3`, `4`
`:DIAG:TEST:FRAM:CLE` *item*	Clears specified test result. *item*: CONT (controller test), FPAN (front panel interface test), LED, PEN, or BEEP
`:DIAG:TEST:FRAM[:EXEC]?` *item*	Executes specified test, then returns test result: `1` (fail), `0` (pass). *item*: CONT (controller test), FPAN (front panel interface test), LED, PEN, or BEEP
`:DIAG:TEST:FRAM:STAT?` *item*	Returns most recent test result of the specified test: `1` (fail), `0` (pass), `-1` (not tested). *item*: CONT (controller test), FPAN (front panel interface test), LED, PEN, or BEEP

SYSTEM subsystem :SYSTem subsystem is a collection of functions that are not related to instrument performance.

Command	Description
`:SYST:BEEP` *state*	Enables/disables the beeper. *state*: `ON` / `1` (enable) or `OFF` / `0` (disable)
`:SYST:CCON?` *card_number*	Returns the card configuration information. This command is just to keep compatibility with the Agilent E5250A. *card_number*: `1`, `2`, `3`, or `4`
`:SYST:CDES?` *card_number*	Returns a description of the specified card: model number and input/output port information. *card_number*: Card to check. `0` for Auto Config, `1`, `2`, `3`, or `4` for Normal Config.
`:SYST:CPON` *card_number*	Resets the specified card to the power-on state. *card_number*: `0` or `ALL` for Auto Config, `1`, `2`, `3`, `4`, or `ALL` for Normal Config
`:SYST:CTYP?` *card_number*	Returns ID of the specified card: model number and revision. *card_number*: Card to check. `0` for Auto Config, `1`, `2`, `3`, or `4` for Normal Config.
`:SYST:DISP:LCD` *state*	Enables/disables the front panel LCD when the B2200 is in the GPIB remote mode. *state*: `ON` / `1` (enable) or `OFF` / `0` (disable)
`:SYST:DISP:LED` *state*	Enables/disables the front panel LED. *state*: `ON` / `1` (enable) or `OFF` / `0` (disable)
`:SYST:DISP:STR` *string*	Specifies a string displayed on the LCD in the GPIB remote mode.
`:SYST:ERR?`	Reads error from head of error queue, and removes it from the queue.
`:SYST:KLC` *state*	Locks/unlocks the front panel keys. *state*: `ON` / `1` (lock) or `OFF` / `0` (unlock)
`:SYST:MEMO:SAVE` *memory_number* `:SYST:MEMO:LOAD` *memory_number*	Saves a setup information into the internal memory, or loads a setup information. *memory_number*: `1` to `8`

Command	Description
:SYST:MEMO:COMM *memory_number*,'*comment*' :SYST:MEMO:COMM? *memory_number*	Memorizes the comment for the B2200 setup information specified by *memory_number*. *memory_number*: 1 to 8
:SYST:MEMO:DEL *memory_number*	Deletes the B2200 setup information and the comment specified by *memory_number*. *memory_number*: 1 to 8
:SYST:PEN *state*	Enables/disables the light pen. *state*: ON / 1 (enable) or OFF / 0 (disable)
:SYST:VERS?	Returns SCPI version number for which the B2200 complies.

:DIAGnostic:TEST:CARD:CLEar

This command clears the relay test result (pass/fail result) of the specified card.

Syntax

`:DIAGnostic:TEST:CARD:CLEar` *card_number*

Parameter	Explanation
card_number	card number: `1`, `2`, `3`, `4`, or `ALL`

Example

```
OUTPUT @Agb2200;":DIAG:TEST:CARD:CLE 1"
```

:DIAGnostic:TEST:CARD[:EXECute]?

This command executes the relay test for specified card, then returns the pass/fail result. Before starting the relay test, open the input/output terminals (end of cable is OK, Kelvin cable must be removed). For more information, see “RELAY_TEST” on page 3-35.

NOTE This command changes all settings of card to same state as after executing :SYST:CPON command.

Syntax

`:DIAGnostic:TEST:CARD[:EXECute]?` *card_number*

Parameter	Explanation
card_number	card number: `1`, `2`, `3`, `4`, or `ALL`

Query response

test_result <newline><^END>

`1`: failure card exists
`0`: pass

Example

```
OUTPUT @Agb2200;":DIAG:TEST:CARD? ALL"
```

:DIAGnostic:TEST:CARD:STATe?

This command returns the most recent relay test result for the specified card.

Syntax

`:DIAGnostic:TEST:CARD:STATe?` *card_number*

Parameter	Explanation
card_number	card number: `1`, `2`, `3`, `4`

Query response

test_result <newline><^END>

`1`: fail
`0`: pass
`-1`: not tested

Example

```
OUTPUT @Agb2200;":DIAG:TEST:CARD:STAT? 1"
ENTER @Agb2200;A
```

:DIAGnostic:TEST:FRAMe:CLEar

This command clears test result of the specified B2200 test.

Syntax

`:DIAGnostic:TEST:FRAMe:CLEar CONTroller | FPANel | LED | PEN | BEEPer`

Parameter	Explanation
CONTroller	Controller test
FPANel	Front panel interface test
LED	LED matrix test
PEN	Light pen test
BEEPer	Beeper test

Example

```
OUTPUT @Agb2200;":DIAG:TEST:FRAM:CLE CONT"
```

:DIAGnostic:TEST:FRAMe[:EXECute]?

This command executes the specified B2200 test, then returns the test result. See “Selftest Menu” on page 3-34 to perform the test.

After the controller test, the B2200 status becomes same as after *RST command execution.

Syntax

```
:DIAGnostic:TEST:FRAMe[:EXECute]? CONTroller | FPANel |
LED | PEN | BEEPer
```

Parameter	Explanation
CONTroller	Controller test
FPANel	Front panel interface test
LED	LED matrix test
PEN	Light pen test
BEEPer	Beeper test

Query response

test_result <newline><^END>

`1`: fail
`0`: pass

Example

```
OUTPUT @Agb2200;":DIAG:TEST:FRAM? CONT"
```

:DIAGnostic:TEST:FRAMe:STATe?

This command returns the most recent test result (pass/fail) of the specified test.

Syntax

```
:DIAGnostic:TEST:FRAMe:STATe? CONTroller | FPANel | LED
| PEN | BEEPer
```

Parameter	Explanation
CONTroller	Controller test
FPANel	Front panel interface test
LED	LED matrix test
PEN	Light pen test
BEEPer	Beeper test

Query response

test_result <newline><^END>

`1`: fail
`0`: pass
`-1`: not tested

Example

```
OUTPUT @Agb2200;":DIAG:TEST:FRAM:STAT? CONT"
ENTER @Agb2200;A
```

[:ROUTe]:AGND:CHANnel:DISable:CARD

This command ground-disables the all output ports (channels) for the specified card. When the Ground Mode is ON, the *ground-disabled* output ports are disconnected from the input Ground Port. At *RST, no channel is ground-enabled. The ground mode is set by “[:ROUTe]:AGND[:STATe]”.

Syntax

`[:ROUTe]:AGND:CHANnel:DISable:CARD` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` or `ALL` For Normal Config mode: `1`, `2`, `3`, `4`, or `ALL`

Example

```
OUTPUT @Agb2200;":ROUT:AGND:CHAN:DIS:CARD ALL"
```

[:ROUTe]:AGND:CHANnel:DISable[:LIST]

This command specifies the *ground-disabled* output ports (channels). When the Ground Mode is ON, the *ground-disabled* output ports are disconnected from the input Ground Port. At *RST, no channel is ground-enabled. The ground mode is set by "[:ROUTe]:AGND[:STATe]".

The query returns whether the specified channels are ground-disabled or not.

Syntax

`[:ROUTe]:AGND:CHANnel:DISable[:LIST]` (*@channel_list*)

`[:ROUTe]:AGND:CHANnel:DISable[:LIST]?` (*@channel_list*)

Parameter	Explanation
channel_list	Channels to ground-disable or to check. For *channel_list*, see "Switch Control" on page 4-5.

Input port is always the input Ground Port. So, the input ports in *channel_list* are ignored. However, you cannot abbreviate the input port.

Query response

disable_status{, *disable_status*} <newline><^END>

`1`: ground disabled
`0`: ground enabled

Example

```
OUTPUT @Agb2200;":ROUT:AGND:CHAN:DIS (@10101)"
OUTPUT @Agb2200;":ROUT:AGND:CHAN:DIS? (@10101,10102,10201)"
ENTER @Agb2200;A$
```

This example ground-disables the output port 1 on the card 1. In this example, `A$` will be `1,0,1`.

[:ROUTe]:AGND:CHANnel:ENABle:CARD

This command ground-enables the all output ports (channels) for the specified card. When the Ground Mode is ON, the *ground-enabled* output ports that have not been connected to any other input port are connected to the input Ground Port. This command is available only for the specified card. At *RST, no channel is ground-enabled. The ground mode is set by "[:ROUTe]:AGND[:STATe]".

Syntax

`[:ROUTe]:AGND:CHANnel:ENABle:CARD` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` or `ALL` For Normal Config mode: `1`, `2`, `3`, `4`, or `ALL`

Example

```
OUTPUT @Agb2200;":ROUT:AGND:CHAN:ENAB:CARD ALL"
```

[:ROUTe]:AGND:CHANnel:ENABle[:LIST]

This command specifies the *ground-enabled* output ports (channels). When the Ground Mode is ON, the *ground-enabled* output ports that have not been connected to any other input port are connected to the input Ground Port. Then, the input Ground Port will not be connected to the output ports that have been connected to any other input port. At *RST, no channel is ground-enabled. The ground mode is set by “[:ROUTe]:AGND[:STATe]”.

The query returns whether the specified channels are ground-enabled or not.

Syntax

`[:ROUTe]:AGND:CHANnel:ENABle[:LIST]` (*@channel_list*)

`[:ROUTe]:AGND:CHANnel:ENABle[:LIST]?` (*@channel_list*)

Parameter	Explanation
channel_list	Channels to ground-enable or to check. For *channel_list*, see “Switch Control” on page 4-5.

Input port is always the input Ground Port. So, the input ports in *channel_list* are ignored. However, you cannot abbreviate the input port number.

Query response

enable_status{, *enable_status*} <newline><^END>

`1`: ground enabled
`0`: ground disabled

Example

```
OUTPUT @Agb2200;":ROUT:AGND:CHAN:ENAB (@10101)"
OUTPUT @Agb2200;":ROUT:AGND:CHAN:ENAB? (@10101,10102,10201)"
ENTER @Agb2200;A$
```

This example ground-enables the output port 1 on the card 1. In this example, `A$` will be `1,0,1`.

[:ROUTe]:AGND:PORT

This command specifies the input Ground Port for the specified card. For each card, you can specify the same or different Ground Port. At *RST, the Ground Port is 12. The ground mode is set by "[:ROUTe]:AGND[:STATe]".

The query returns the input port number of the Ground Port.

NOTE

The input ground port and a ground enabled input port cannot be assigned to the same input port.

If the input ground port and a couple port have been assigned to the same input port, the ground mode and the couple mode cannot be used in parallel.

0 V output voltage source should be connected to the input Ground Port. Or set *ground_port* to 12, and open the input port 12 that is the default ground port. If you assign the input 12 as the ground port, this ground port will be internally connected to the ground when the ground mode is set to ON.

Syntax

`[:ROUTe]:AGND:PORT` *card_number*`,`*ground_port*

`[:ROUTe]:AGND:PORT?` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` or `ALL` For Normal Config mode: `1`, `2`, `3`, `4`, or `ALL` `ALL` is not available for query.
ground_port	Input port number: `1` to `14`. Or `-1` to disable ground port.

Query response

port_number <newline><^END>

port_number = `1` to `14` or `-1`. Number set to *ground_port*.

Example

```
OUTPUT @Agb2200;":ROUT:AGND:PORT 0,13"
OUTPUT @Agb2200;":ROUT:AGND:PORT? 0"
ENTER @Agb2200;A
```

In this example, `A` will be `13`.

[:ROUTe]:AGND[:STATe]

NOTE You cannot set the Ground Mode to ON when the Bias Mode is ON.

This command controls the Ground Mode for the specified card. When the Ground Mode is ON, the input Ground Port is connected to the all *ground-enabled* input ports/output ports that have not been connected to any other port. At *RST, the Ground Mode is OFF.

The query returns the mode status.

The input Ground Port is set by "[:ROUTe]:AGND:PORT". The *ground-enabled* input ports are set by "[:ROUTe]:AGND:UNUSED". And the *ground-enabled* output ports are set by "[:ROUTe]:AGND:CHANnel:ENABle[:LIST]" or "[:ROUTe]:AGND:CHANnel:ENABle:CARD".

When the Ground Mode is ON, you cannot directly control the Ground Port connections. However, they can be indirectly controlled when the connections of the other input port are controlled.

When the Ground Mode is OFF, the input Ground Port is the same as the other input ports, so relays can be controlled directly to connect to output ports.

Syntax

`[:ROUTe]:AGND[:STATe]` *card_number*`,`*state*

`[:ROUTe]:AGND[:STATe]?` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` or `ALL` For Normal Config mode: `1`, `2`, `3`, `4`, or `ALL` `ALL` is not available for query.
state	`ON` or `1`: sets the Ground Mode ON `OFF` or `0`: sets the Ground Mode OFF

Query response

state <newline><^END>

`0`: OFF or `1`: ON

Example

```
OUTPUT @Agb2200;":ROUT:AGND:STAT 0,ON"
OUTPUT @Agb2200;":ROUT:AGND:STAT? 0"
ENTER @Agb2200;A
```

In this example, `A` will be `1`.

[:ROUTe]:AGND:UNUSED

This command specifies the *ground-enabled* input ports for the specified card. When the Ground Mode is ON, the *ground-enabled* input ports that have not been connected to any other port are connected to the input Ground Port. At *RST, no input port is ground-enabled. The ground mode is set by "[:ROUTe]:AGND[:STATe]".

The query returns which input ports are ground-enabled.

NOTE

The input ground port and a ground enabled input port cannot be assigned to the same input port.

If the ground enabled input port and a couple port have been assigned to the same input port, the ground mode and the couple mode cannot be used in parallel.

CAUTION

Open the input ports set to this command. If any equipment is connected to the *ground-enabled* input ports, turning the Ground Mode ON may cause damage in the equipment.

Syntax

`[:ROUTe]:AGND:UNUSED` *card_number*`,'`*port_number*`'`

`[:ROUTe]:AGND:UNUSED?` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` or `ALL` For Normal Config mode: `1`, `2`, `3`, `4`, or `ALL` `ALL` is not available for query.
port_number	Input port number: `1` to `8`. Enclose by single quotation marks. Separate multiple input port numbers by comma. For example: `'1,5'`

Query response

port_number{, *port_number*} <newline><^END>

port_number = `1` to `8`

Example

```
OUTPUT @Agb2200;":ROUT:AGND:UNUSED 0,'5,6,7,8'"
OUTPUT @Agb2200;":ROUT:AGND:UNUSED? 0"
ENTER @Agb2200;A$
```

In this example, `A$` will be `5,6,7,8`.

[:ROUTe]:BIAS:CHANnel:DISable:CARD

This command bias-disables the all output ports (channels) for the specified card. When the Bias Mode is ON, the *bias-disabled* output ports are disconnected from the input Bias Port. At *RST, all cards are bias-enabled. The bias mode is set by "[:ROUTe]:BIAS[:STATe]".

Syntax

`[:ROUTe]:BIAS:CHANnel:DISable:CARD` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` or `ALL` For Normal Config mode: `1`, `2`, `3`, `4`, or `ALL`

Example

```
OUTPUT @Agb2200;":ROUT:BIAS:CHAN:DIS:CARD ALL"
```

[:ROUTe]:BIAS:CHANnel:DISable[:LIST]

This command specifies the *bias-disabled* output ports (channels). When the Bias Mode is ON, the *bias-disabled* output ports are disconnected from the input Bias Port. At *RST, all channels are bias-enabled. The bias mode is set by "[:ROUTe]:BIAS[:STATe]".

The query returns whether the specified channels are bias-disabled or not.

Syntax

`[:ROUTe]:BIAS:CHANnel:DISable[:LIST]` (*@channel_list*)

`[:ROUTe]:BIAS:CHANnel:DISable[:LIST]?` (*@channel_list*)

Parameter	Explanation
channel_list	Channels to bias-disable or to check. For *channel_list*, see "Switch Control" on page 4-5.

Input port is always the input Bias Port. So, the input ports in *channel_list* are ignored. However, you cannot abbreviate the input port.

Query response

disable_status{, *disable_status*} <newline><^END>

`1`: bias disabled
`0`: bias enabled

Example

```
OUTPUT @Agb2200;":ROUT:BIAS:CHAN:ENAB:CARD ALL"
OUTPUT @Agb2200;":ROUT:BIAS:CHAN:DIS (@10101)"
OUTPUT @Agb2200;":ROUT:BIAS:CHAN:DIS? (@10101,10102,10201)"
ENTER @Agb2200;A$
```

This example bias-disables the output port 1 on the card 1. In this example, `A$` will be `1,0,1`.

[:ROUTe]:BIAS:CHANnel:ENABle:CARD

This command bias-enables the all output ports (channels) for the specified card. When the Bias Mode is ON, the *bias-enabled* output ports that have not been connected to any other input port are connected to the input Bias Port. This command is available only for the specified card. At *RST, all cards are bias-enabled. The bias mode is set by "[:ROUTe]:BIAS[:STATe]".

Syntax

`[:ROUTe]:BIAS:CHANnel:ENABle:CARD` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` or `ALL` For Normal Config mode: `1`, `2`, `3`, `4`, or `ALL`

Example

```
OUTPUT @Agb2200;":ROUT:BIAS:CHAN:ENAB:CARD ALL"
```

[:ROUTe]:BIAS:CHANnel:ENABle[:LIST]

This command specifies the *bias-enabled* output ports (channels). When the Bias Mode is ON, the *bias-enabled* output ports that have not been connected to any other input port are connected to the input Bias Port. Then, the input Bias Port will not be connected to the output ports that have been connected to any other input port. At *RST, all channels are bias-enabled. The bias mode is set by "[:ROUTe]:BIAS[:STATe]".

The query returns whether the specified channels are bias-enabled or not.

Syntax

`[:ROUTe]:BIAS:CHANnel:ENABle[:LIST]` (*@channel_list*)

`[:ROUTe]:BIAS:CHANnel:ENABle[:LIST]?` (*@channel_list*)

Parameter	Explanation
channel_list	Channels to bias-enable or to check. For *channel_list*, see "Switch Control" on page 4-5.

Input port is always the input Bias Port. So, the input ports in *channel_list* are ignored. However, you cannot abbreviate the input port.

Query response *enable_status*{, *enable_status*} <newline><^END>

`1`: bias enabled
`0`: bias disabled

Example

```
OUTPUT @Agb2200;":ROUT:BIAS:CHAN:DIS:CARD ALL"
OUTPUT @Agb2200;":ROUT:BIAS:CHAN:ENAB (@10101)"
OUTPUT @Agb2200;":ROUT:BIAS:CHAN:ENAB? (@10101,10102,10201)"
ENTER @Agb2200;A$
```

This example bias enables the output port 1 on the card 1. In this example, `A$` will be `1,0,1`.

[:ROUTe]:BIAS:PORT

NOTE If the input bias port and a couple port have been assigned to the same input port, the bias mode and the couple mode cannot be used in parallel.

This command specifies the input Bias Port for the specified card. For each card, you can specify the same or different Bias Port. At *RST, Bias Port is set to 10. The bias mode is set by "[:ROUTe]:BIAS[:STATe]". The query returns the input Bias Port number for the specified card.

Syntax `[:ROUTe]:BIAS:PORT` *card_number*`,`*bias_port*

`[:ROUTe]:BIAS:PORT?` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` or `ALL` For Normal Config mode: `1`, `2`, `3`, `4`, or `ALL` `ALL` is not available for query.
bias_port	Input port number: `1` to `14`. Or `-1` to disable bias port.

Query response *port_number* <newline><^END>

port_number = `1` to `14` or `-1`. Number set to *bias_port*.

Example

```
OUTPUT @Agb2200;":ROUT:BIAS:PORT ALL,4"
OUTPUT @Agb2200;":ROUT:BIAS:PORT? 1"
ENTER @Agb2200;A
```

In this example, A will be 4.

[:ROUTe]:BIAS[:STATe]

NOTE You cannot set the Bias Mode to ON when the Ground Mode is ON.

This command controls the Bias Mode for the specified card. When the Bias Mode is ON, the input Bias Port is connected to the all *bias-enabled* output ports that have not been connected to any other input port. At *RST, the Bias Mode is OFF.

The query returns the mode status of the specified card.

The input Bias Port is set by "[:ROUTe]:BIAS:PORT". The *bias-enabled* output ports (channels) are set by "[:ROUTe]:BIAS:CHANnel:ENABle[:LIST]" or "[:ROUTe]:BIAS:CHANnel:ENABle:CARD".

When the Bias Mode is ON, you cannot directly control the Bias Port connections. However, they can be indirectly controlled when the connections of the other input port are controlled.

When the Bias Mode is OFF, the input Bias Port is the same as the other input ports, so relays can be controlled directly to connect to output ports.

Syntax

`[:ROUTe]:BIAS[:STATe]` *card_number*`,`*state*

`[:ROUTe]:BIAS[:STATe]?` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` or `ALL` For Normal Config mode: `1`, `2`, `3`, `4`, or `ALL` `ALL` is not available for query.
state	`ON` or `1`: sets the Bias Mode ON `OFF` or `0`: sets the Bias Mode OFF

Query response

0 or 1 <newline><^END>

`0`: OFF
`1`: ON

Example

```
OUTPUT @Agb2200;":ROUT:BIAS:STAT ALL,ON"
OUTPUT @Agb2200;":ROUT:BIAS:STAT? 4"
ENTER @Agb2200;A
```

In this example, A will be 1.

[:ROUTe]:CLOSe:CARD?

This query command returns *channel_list* of all closed (connected) channels for the specified card.

Syntax

`[:ROUTe]:CLOSe:CARD?` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` For Normal Config mode: `1`, `2`, `3`, or `4`

Query response

channel_list <newline><^END>

Example

```
OUTPUT @Agb2200;":ROUT:OPEN:CARD ALL"
OUTPUT @Agb2200;":ROUT:CLOS (@10101,10202)"
OUTPUT @Agb2200;":ROUT:CLOS:CARD? 1"
ENTER @Agb2200;A$
```

`A$` will be `@10101,10202`. For *channel_list*, see “Switch Control” on page 4-5.

[:ROUTe]:CLOSe[:LIST]

This command connects the input ports to the output ports (channels) as specified in *channel_list*. The query returns `0` or `1` for each channel specified by *channel_list*, in same order as specified by *channel_list*.

For some modes (such as Single Route Mode, Couple Mode, Ground Mode, and Bias Mode), more complex connections may occur.

Syntax

`[:ROUTe]:CLOSe[:LIST]` (*@channel_list*)

`[:ROUTe]:CLOSe[:LIST]?` (*@channel_list*)

Parameter	Explanation
channel_list	Channels to close or to check. For *channel_list*, see “Switch Control” on page 4-5.

Query response

close_status{, *close_status*} <newline><^END>

`1`: closed
`0`: opened

Example

```
OUTPUT @Agb2200;":ROUT:CLOS (@10101,10202)"
OUTPUT @Agb2200;":ROUT:CLOS? (@10101,10102,10201,10202)"
ENTER @Agb2200;A$
```

In this example, A$ will be 1,0,0,1.

[:ROUTe]:CONNection:RULE

This command sets the connection rule (Free or Single Route) for the specified card. The query returns the connection rule of the specified card. At *RST, all cards are set to FREE. See “Connection Rule” on page 3-14.

Syntax

`[:ROUTe]:CONNection:RULE` *card_number*`,`*rule*

`[:ROUTe]:CONNection:RULE?` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` or `ALL` For Normal Config mode: `1`, `2`, `3`, `4`, or `ALL` `ALL` is not available for query.
rule	`FREE` (free route) or `SROUte` (single route). In the free route, multiple channel connections are available for all input ports. In the single route, only 1 channel connection is available for each input port.

Query response

FREE or SROU <newline><^END>

Example

```
OUTPUT @Agb2200;":ROUT:CONN:RULE ALL,SROU"
OUTPUT @Agb2200;":ROUT:CONN:RULE? 1"
ENTER @Agb2200;A$
```

In this example, A$ will be SROU.

[:ROUTe]:CONNection:SEQuence

This command specifies the connection sequence mode, which is the open/close sequence of the relays when connection route is changed from an existing connection to a new connection. The query returns the connection sequence mode of the specified card. At *RST, BBMake is selected. See “Connection Sequence” on page 3-15.

The connection sequence is used only for cards that have been set to SROUte connection rule. Also see “[:ROUTe]:CONNection:RULE”.

Syntax

`[:ROUTe]:CONNection:SEQuence` *card_number*`,`*sequence*

`[:ROUTe]:CONNection:SEQuence?` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` or `ALL` For Normal Config mode: `1`, `2`, `3`, `4`, or `ALL` `ALL` is not available for query.
sequence	`NSEQ`: No-Sequence mode `BBM`: Break-Before-Make mode `MBBR`: Make-Before-Break mode

Query response

`NSEQ` or `BBM` or `MBBR` <newline><^END>

Example

```
OUTPUT @Agb2200;":ROUT:CONN:SEQ ALL,MBBR"
OUTPUT @Agb2200;":ROUT:CONN:SEQ? 0"
ENTER @Agb2200;A$
```

In this example, `A$` will be `MBBR`.

[:ROUTe]:COUPle:PORT

NOTE

If the input bias port and a couple port have been assigned to the same input port, the bias mode and the couple mode cannot be used in parallel.

If the input ground port and a couple port have been assigned to the same input port, the ground mode and the couple mode cannot be used in parallel.

If the ground enabled input port and a couple port have been assigned to the same input port, the ground mode and the couple mode cannot be used in parallel.

This command is used to set up input couple ports, which are used for the Kelvin connections. The couple mode is set by "[:ROUTe]:COUPle[:STATe]".

For each card, you can set up the same or different input couple ports.

This command overwrites the previous couple port setting. The couple port setting will be cleared and updated by "[:ROUTe]:COUPle:PORT:DETect".

The query returns the *odd* input port number of each coupled pair.

At *RST, no input ports are coupled.

Syntax

`[:ROUTe]:COUPle:PORT` *card_number*`,'`*couple_port*`'`

`[:ROUTe]:COUPle:PORT?` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` or `ALL` For Normal Config mode: `1`, `2`, `3`, `4`, or `ALL` `ALL` is not available for query.
couple_port	One or more input port numbers: `1`, `3`, `5`, `7`, `9`, `11` or `13`. Enclose by single quotation marks. Separate multiple input port numbers by comma. For example: `'1,5'`

Query response

port_number{, *port_number*} <newline><^END>

port_number = `1` or `3` or `5` or `7` or `9` or `11` or `13`

Example

```
OUTPUT @Agb2200;":ROUT:COUP:PORT ALL,'1,3'"
OUTPUT @Agb2200;":ROUT:COUP:PORT? 1"
ENTER @Agb2200;A$
```

In this example, `A$` will be `1,3`.

[:ROUTe]:COUPle:PORT:DETect

This command detects the input ports connected to the Kelvin cable, and assigns them as the input couple ports that will be used for the Kelvin connection. The input couple port setting is effective for the all cards. This command overwrites the previous couple port setting.

The couple mode is set by “[:ROUTe]:COUPle[:STATe]”. The couple port setting will be cleared and updated by “[:ROUTe]:COUPle:PORT”.

The input port numbers of the couple ports can be got by [:ROUTe]:COUPle:PORT?.

After this command is executed, the all relay settings will be the same as after the :ROUT:OPEN:CARD ALL command execution.

Syntax

```
[:ROUTe]:COUPle:PORT:DETect
```

Example

```
OUTPUT @Agb2200;":ROUT:COUP:PORT:DET"
```

[:ROUTe]:COUPle[:STATe]

This command controls the Couple Mode for the specified card. The query returns the mode status of the specified card. At *RST, the Couple Mode is OFF.

The input couple ports are set by "[:ROUTe]:COUPle:PORT:DETect" or "[:ROUTe]:COUPle:PORT".

If you specify a connection from a couple input port to an output port when the couple mode is ON, the B2200 automatically controls relays to connect the input ports *n*-1 and *n* to the output ports *m*-1 and *m* respectively (*n*: an even number from 2 to 14, *m*: an even number from 2 to 12, 2 to 24, 2 to 36, or 2 to 48 depends on the B2200 configuration). See example below.

Syntax

`[:ROUTe]:COUPle[:STATe]` *card_number*`,`*state*

`[:ROUTe]:COUPle[:STATe]?` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` or `ALL` For Normal Config mode: `1`, `2`, `3`, `4`, or `ALL` `ALL` is not available for query.
state	`ON` or `1`: sets the Couple Mode ON `OFF` or `0`: sets the Couple Mode OFF

Query response

state <newline><^END>

`0`: OFF
`1`: ON

Example

```
OUTPUT @Agb2200;":ROUT:COUP:STAT ALL,ON"
OUTPUT @Agb2200;":ROUT:COUP:STAT? 2"
ENTER @Agb2200;A
```

In this example, `A` will be `1`.

```
OUTPUT @Agb2200;":ROUT:COUP:PORT ALL,'1'"
OUTPUT @Agb2200;":ROUT:COUP:STAT ALL,ON"
OUTPUT @Agb2200;":ROUT:CLOS (@10103)"
```

This example controls the card 1 relays and connects the inputs 1 and 2 to the outputs 3 and 4 respectively. `:ROUT:CLOS (@10104)` will make the same result.

[:ROUTe]:FUNCtion

This command sets the channel configuration, which determines how you specify the *channel_list* or *card_number* in other commands. The query returns the present channel configuration. At *RST, this parameter is set to ACONfig. See “Channel Configuration Mode” on page 3-13.

When configuration is changed by this command, all channels are opened (disconnected) and become same status as after :SYSTem:CPON ALL execution.

Syntax

`[:ROUTe]:FUNCtion` *channel_config*

`[:ROUTe]:FUNCtion?`

Parameter	Explanation
channel_config	ACONfig: Auto Config Mode NCONfig: Normal Config Mode

Query response

ACON or NCON <newline><^END>

Example

```
OUTPUT @Agb2200;":ROUT:FUNC ACON"
OUTPUT @Agb2200;":ROUT:FUNC?"
ENTER @Agb2200;A$
```

In this example, A$ will be ACON.

[:ROUTe]:OPEN:CARD

This command disconnects all input ports from all output ports for the specified card. For some modes (such as Single Route Mode, Couple Mode, Ground Mode, and Bias Mode), more complex disconnections may occur.

Syntax

`[:ROUTe]:OPEN:CARD` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: 0 or ALL For Normal Config mode: 1, 2, 3, 4, or ALL

Example

```
OUTPUT @Agb2200;":ROUT:OPEN:CARD ALL"
```

[:ROUTe]:OPEN[:LIST]

This command disconnects the input ports from output ports as specified in *channel_list*. The query returns `0` or `1` for each channel specified by *channel_list*, in same order as specified by *channel_list*.

For some modes (such as Single Route Mode, Couple Mode, Ground Mode, and Bias Mode), more complex disconnections may occur.

Syntax

`[:ROUTe]:OPEN[:LIST]` (*@channel_list*)

`[:ROUTe]:OPEN[:LIST]?` (*@channel_list*)

Parameter	Explanation
channel_list	Channels to open (disconnect) or to check. For *channel_list*, see “Switch Control” on page 4-5.

Query response

open_status{, *open_status*} <newline><^END>

`1` : opened
`0` : closed

Example

```
OUTPUT @Agb2200;":ROUT:OPEN:CARD ALL"
OUTPUT @Agb2200;":ROUT:CLOS (@10101,10202)"
OUTPUT @Agb2200;":ROUT:OPEN? (@10101,10102,10201,10202)"
ENTER @Agb2200;A$
```

In this example, `A$` will be `0,1,1,0`.

[:ROUTe]:SYMBol:CHANnel

In the GPIB local mode, the B2200 uses 01 to 48 (two digits numbers) to specify the output ports (channels) 1 to 48 respectively. This command specifies a symbol string and lets the B2200 use the specified string instead of the two digits number. The query returns the symbol string.

Maximum value of the two digits number depends on the B2200 configuration. It is 12 for the normal configuration mode or the auto configuration mode with one matrix card, 24 for the auto configuration mode with two matrix cards, 36 for the auto configuration mode with three matrix cards, or 48 for the auto configuration mode with four matrix cards.

Reboot, *RST, and :SYSTem:CPON clear the symbol strings. After that, the initial symbol string (two digits numbers 01 to 48) will be set.

Syntax

`[:ROUTe]:SYMBol:CHANnel` *card_number*`,`*channel_number*`,'`*string*`'`

`[:ROUTe]:SYMBol:CHANnel?` *card_number*`,`*channel_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` or `ALL` For Normal Config mode: `1`, `2`, `3`, `4`, or `ALL` `ALL` is not available for query.
channel_number	Output port number: `1` to `48` for Auto, `1` to `12` for Normal.
string	Symbol string set to the specified output port (channel). Maximum 6 characters. Numeric characters, alphabetic characters; upper case and lower case, space, and the following symbols are available. ! " # $ % & ’ ( ) * + , - . / > ? : ~ ; < = > ? @ [\ ] ‘ { | } ^ _

Query response

string <newline><^END>

Example

```
OUTPUT @Agb2200;":ROUT:SYMB:CHAN 0,10,'GATE'"
OUTPUT @Agb2200;":ROUT:SYMB:CHAN? 0,10"
ENTER @Agb2200;A$
```

This example assigns the string `GATE` to the output port 10. After that, `GATE` is used instead of `10`. In this example, `A$` will be `GATE`.

[:ROUTe]:SYMBol:PORT

In the GPIB local mode, the B2200 uses 01 to 14 (two digits numbers) to specify the input ports 1 to 14 respectively. This command specifies a symbol string and lets the B2200 use the specified string instead of the two digits number. The query returns the symbol string.

Reboot and *RST clear the symbol strings. After that, the initial symbol string (two digits numbers 01 to 14) will be set.

:SYSTem:CPON does not clear the symbol strings.

Syntax

`[:ROUTe]:SYMBol:PORT` *port_number*`,'`*symbol_string*`'`

`[:ROUTe]:SYMBol:PORT?` *port_number*

Parameter	Explanation
port_number	Input port number: `1` to `14`.
symbol_string	Symbol string set to the specified input port. Maximum 6 characters. Numeric characters, alphabetic characters; upper case and lower case, space, and the following symbols are available. ! " # $ % & ’ ( ) * + , - . / > ? : ~ ; < = > ? @ [\ ] ‘ { | } ^ _

Query response

symbol_string <newline><^END>

Example

```
OUTPUT @Agb2200;":ROUT:SYMB:PORT 1,'SMU1'"
OUTPUT @Agb2200;":ROUT:SYMB:PORT? 1"
ENTER @Agb2200;A$
```

This example assigns the string `SMU1` to the input port 1. After that, `SMU1` is used instead of `01`. In this example, `A$` will be `SMU1`.

:SYSTem:BEEP

This command enables/disables the beeper.

Syntax

`:SYSTem:BEEP` *state*

Parameter	Explanation
state	`ON` or `1`: enables the beeper `OFF` or `0`: disables the beeper

Example

```
OUTPUT @Agb2200;":SYST:BEEP ON"
```

:SYSTem:CCONfig?

This query command is just to keep compatibility with the Agilent E5250A Low Leakage Switch Mainframe. This query command returns the card configuration information.

Syntax

`:SYSTem:CCONfig?` *card_number*

Parameter	Explanation
card_number	card number: 1, 2, 3, or 4

Query response

card_configuration <newline><^END>

Always returns `#10`.

Example

```
OUTPUT @Agb2200;":SYST:CCON? 1"
ENTER @Agb2200;A$
PRINT "Card configuration = ";A$
```

:SYSTem:CDEScription?

This query command returns a description of the specified card.

Syntax

`:SYSTem:CDEScription?` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` For Normal Config mode: `1`, `2`, `3`, or `4`

Query response

"*card_description*" <newline><^END>

If the designated card is not installed or initialize failed, this command returns `"No Card"`.

For B2200A:

- In the Auto Config mode, "*card_description*" response is one of following:
  - `"B2210A 14x12 Femto Leakage Switch Module"`
  - `"B2210A 14x24 Femto Leakage Switch Module"`
  - `"B2210A 14x36 Femto Leakage Switch Module"`
  - `"B2210A 14x48 Femto Leakage Switch Module"`
- In the Normal Config mode:

  `"B2210A 14x12 Femto Leakage Switch Module"`

For B2201A:

- In the Auto Config mode, "*card_description*" response is one of following:
  - `"B2211A 14x12 Low Leakage Switch Module"`
  - `"B2211A 14x24 Low Leakage Switch Module"`
  - `"B2211A 14x36 Low Leakage Switch Module"`
  - `"B2211A 14x48 Low Leakage Switch Module"`
- In the Normal Config mode:

  `"B2211A 14x12 Low Leakage Switch Module"`

Example

```
OUTPUT @Agb2200;":SYST:CDES? 1"
ENTER @Agb2200;A$
```

:SYSTem:CPON

This command resets the specified card. Status after this command is shown below:

Channel Configuration: Not changed.

Connection Rule: Free

Connection Sequence: Break Before Make

Bias Mode: Off

Bias Input Port: 10

Bias-enabled Channels: All channels (output ports) are bias-enabled.

Couple Mode: Off

Couple Input Port: Cleared.

Ground Mode: Off

Ground Input Port: 12

Ground-enabled Channels: Cleared.

Ground-enabled Ports: Cleared.

Card Channel Status: All relays are opened.

Self-Test Result: Not changed.

Input Port Symbol String: Not changed.

Output Port Symbol String: Cleared.

For the device reset state, see *RST.

Syntax

`:SYSTem:CPON` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` or `ALL` For Normal Config mode: `1`, `2`, `3`, `4`, or `ALL`

Example

```
OUTPUT @Agb2200;":SYST:CPON ALL"
```

:SYSTem:CTYPe?

This query command returns the ID of the specified card.

Syntax

`:SYSTem:CTYPe?` *card_number*

Parameter	Explanation
card_number	For Auto Config mode: `0` For Normal Config mode: `1`, `2`, `3`, or `4`

Query response

`AGILENT TECHNOLOGIES,`*model*`,0,`*revision* <newline><^END>

model = `B2210A` or `B2211A`

revision = `1` or later version

If designated card is not installed or initialize failed, this command returns `NONE,NONE,0,0`.

Example

```
OUTPUT @Agb2200;":SYST:CTYPE? 1"
ENTER @Agb2200;A$
```

:SYSTem:DISPlay:LCD

This command enables/disables the front panel Liquid Crystal Display when the B2200 is in the GPIB remote mode. The front panel LCD will be automatically set to ON by the mode transition from GPIB remote to GPIB local.

Syntax

`:SYSTem:DISPlay:LCD` *state*

Parameter	Explanation
state	`ON` or `1`: enables the LCD `OFF` or `0`: disables the LCD (initial setting)

Even though *state* is OFF, some status indicators on the LCD will be effective.

Example

```
OUTPUT @Agb2200;":SYST:DISP:LCD 1"
```

:SYSTem:DISPlay:LED

This command enables/disables the front panel Light Emitting Diodes matrix when the B2200 is in the GPIB remote mode. The front panel LED matrix will be automatically set to ON by the mode transition from GPIB remote to GPIB local.

Syntax `:SYSTem:DISPlay:LED` *state*

Parameter	Explanation
state	`ON` or `1`: enables the LEDs (initial setting) `OFF` or `0`: disables the LEDs

Example

```
OUTPUT @Agb2200;":SYST:DISP:LED 1"
```

:SYSTem:DISPlay:STRing

When the B2200 is in the GPIB remote mode, you can display a string (maximum 39 characters) on the front panel LCD. This command specifies the string and displays it on the LCD.

The specified string data is only displayed on the front panel LCD. It is not memorized. So a display-change operation will clear and delete the string data.

Syntax `:SYSTem:DISPlay:STRing '`*string*`'`

Parameter	Explanation
string	String to be displayed on the front panel LCD. Maximum 38 characters. Numeric characters, alphabetic characters; upper case and lower case, space, and the following symbols are available. ! " # $ % & ’ ( ) * + , - . / > ? : ~ ; < = > ? @ [\ ] ‘ { | } ^ _

Example

```
OUTPUT @Agb2200;":SYST:DISP:STR 'E:SMU1,B:SMU2,C:SMU3'"
```

This example displays `E:SMU1,B:SMU2,C:SMU3` on the front panel LCD.

:SYSTem:ERRor?

This query command reads the error from the head of the error queue and removes that error from the queue.

Syntax

```
:SYSTem:ERRor?
```

Query response

err_no,"*message*" <newline><^END>

err_no is numeric response data, and *message* is string response data.

If there has been no error (error queue is empty), the response to this query is as follows:

```
0,"No error"
```

Example

```
OUTPUT @Agb2200;":SYST:ERR?"
ENTER @Agb2200;A,B$
```

:SYSTem:KLC

This command locks/unlocks the front panel keys.

Syntax

```
:SYSTem:KLC state
```

Parameter	Explanation
state	`ON` or `1`: lock `OFF` or `0`: unlock

Example

```
OUTPUT @Agb2200;":SYST:KLC ON"
```

:SYSTem:MEMOry:COMMent

This command memorizes the comment for the B2200 setup information specified by *memory_number*. The previous comment will be deleted. The query returns the comment for the specified setup.

Syntax

`:SYSTem:MEMOry:COMMent` *memory_number*`,'`*comment*`'`

`:SYSTem:MEMOry:COMMent?` *memory_number*

Parameter	Explanation
memory_number	memory number: 1 to 8.
comment	Comment. Maximum 16 characters. If this command is entered with empty *comment*, the comment will be cleared. Numeric characters, alphabetic characters; upper case and lower case, space, and the following symbols are available. ! " # $ % & ’ ( ) * + , - . / > ? : ~ ; < = > ? @ [\ ] ‘ { | } ^ _

Example

```
OUTPUT @Agb2200;":SYST:MEMO:COMM 1,'1-1,2-13,3-25'"
OUTPUT @Agb2200;":SYST:MEMO:COMM? 1"
ENTER @Agb2200;A$
```

In this example, `A$` will be `1-1,2-13,3-25`.

:SYSTem:MEMOry:DELete

This command deletes the B2200 setup information and the comment specified by *memory_number*.

Syntax

`:SYSTem:MEMOry:DELete` *memory_number*

Parameter	Explanation
memory_number	memory number: 1 to 8.

Example

```
OUTPUT @Agb2200;":SYST:MEMO:DEL 1"
```

:SYSTem:MEMOry:LOAD

This command restores the B2200 setup information specified by *memory_number*. It must be already saved by ":SYSTem:MEMOry:SAVE".

Syntax

`:SYSTem:MEMOry:LOAD` *memory_number*

Parameter	Explanation
memory_number	memory number: 1 to 8.

Example

```
OUTPUT @Agb2200;":SYST:MEMO:SAVE 1"
OUTPUT @Agb2200;":SYST:MEMO:LOAD 1"
```

:SYSTem:MEMOry:SAVE

This command saves the present setup information of the B2200 into the internal memory specified by *memory_number*. The previous setup will be deleted. To memorize the comment for the setup information, use ":SYSTem:MEMOry:COMMent".

The following setup information will be saved.

- Configuration mode
- Connection rule, connection sequence
- Bias mode status, bias ports, *bias-enabled* channels
- Couple mode status, couple ports
- Ground mode status, ground ports, *ground-enabled* channels, *ground-enabled* ports
- Connection status of all switches
- Symbol string of all input ports and output ports

Syntax

`:SYSTem:MEMOry:SAVE` *memory_number*

Parameter	Explanation
memory_number	memory number: 1 to 8.

Example

```
OUTPUT @Agb2200;":SYST:MEMO:SAVE 1"
```

:SYSTem:PEN

This command enables/disables the light pen.

Syntax

`:SYSTem:PEN` *state*

Parameter	Explanation
state	`ON` or `1`: enables the light pen `OFF` or `0`: disables the light pen

Example

```
OUTPUT @Agb2200;":SYST:PEN ON"
```

:SYSTem:VERSion?

This query command returns the SCPI version number for which the B2200 complies.

Syntax

:SYSTem:VERSion?

Query response

YYYY.V <newline><^END>

YYYY is the year (for example, `2004`).

V is the approved revision number for that year.

Example

```
OUTPUT @Agb2200;":SYST:VERS?"
ENTER @Agb2200;A$
```

Status Reporting Structure

This section describes the status reporting structure used in the B2200. These are IEEE 488.2 status structures that can be set and read by the SCPI Common Commands as described in “Common Commands” on page 5-4.

Status Reporting Structure

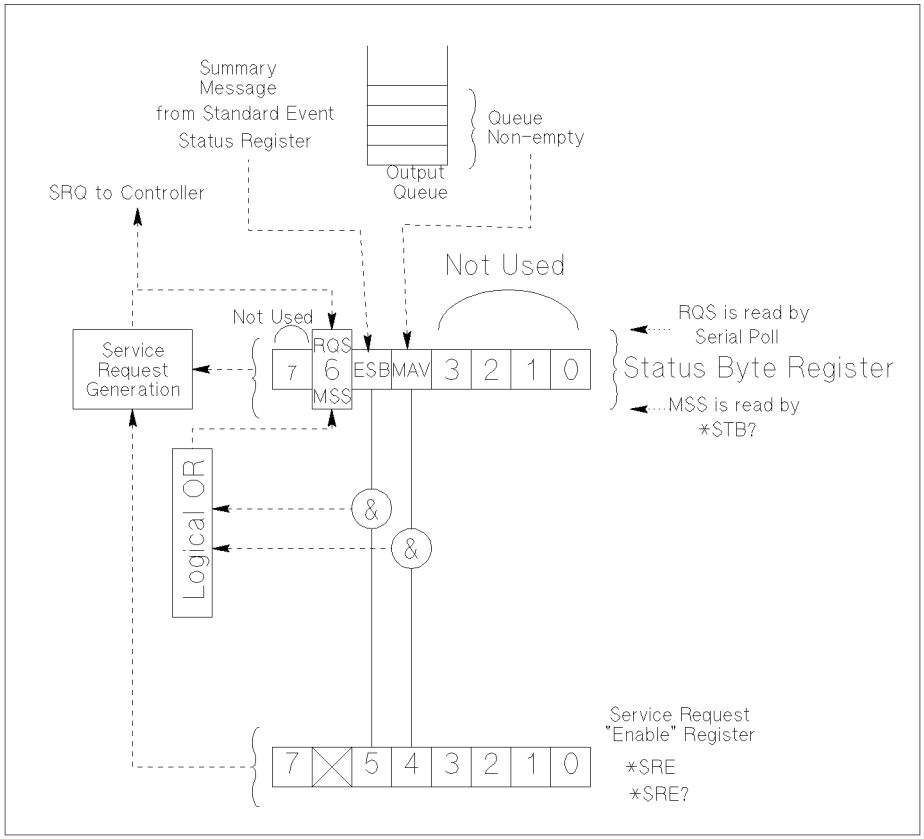
The status reporting structure consists of the following:

- Status Byte Register
- Service Request “Enable” Register
- Standard Event Status Register
- Standard Event Status “Enable” Register
- Output Queue

In general, the status reporting structure is used to request service via Service Request (SRQ) or to indicate a specific condition, such as operation complete.

See the following figures for a model of the B2200 status reporting structure.

Figure 5-1 **Status Reporting Structure of B2200**



PG04001 120x120

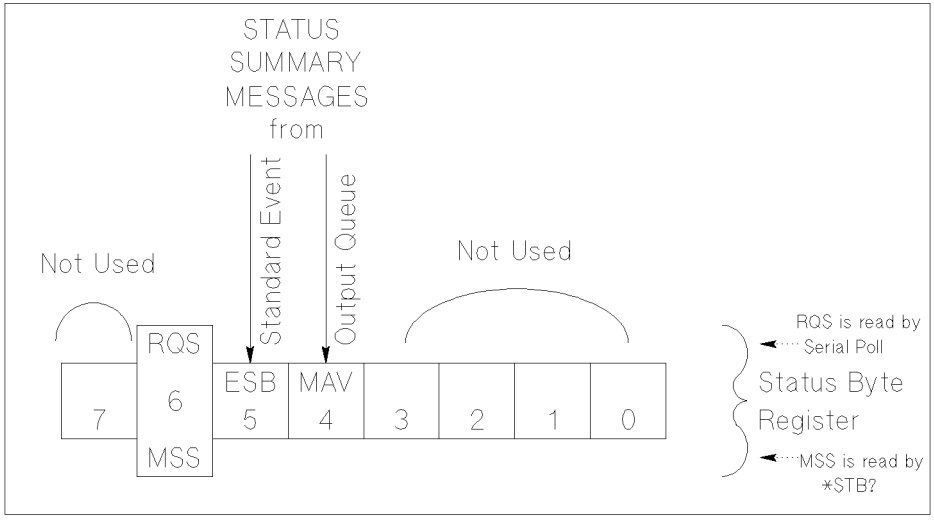
The above figure shows Service Request Generation. When a condition occurs that requires service, the instrument sets Request Service bit (RQS – bit6) of Status Byte, and sends a Service Request (SRQ) via GPIB bus to the controller. So, the controller can execute an interrupt service routine (must be in the program) that uses a Serial Poll to read Status Byte of each instrument to determine which instrument requested service. See “Status Byte Register” on page 5-55.

Status Byte Register

The B2200 Status Byte Register contains bits (ESB and MAV) for status summary messages from other registers. The status of these bits depends on the condition of the Standard Event Status Register and the Output Queue. If service request occurs, Bit6 (RQS) of Status Byte Register is set.

See Figure 5-2 and Table 5-1 for the B2200 Status Byte Register.

Figure 5-2 **Status Byte Register of B2200**



The Status Byte Register can be read with either a serial poll or the *STB? common query command (see “Common Commands” on page 5-4).

Serial poll is a low-level GPIB command that can be executed by `SPOLL` in HP BASIC, such as the following:

```
Status=SPOLL(@Agb2200)
```

Both serial poll and STB? read the Status Byte Register identically, but have following difference:

- `SPOLL` returns RQS for bit6
- *STB? returns MSS for bit6

RQS and MSS are always the same value, so returned Status Byte value is always the same for these two methods.

In general, use serial polling (not *STB?) inside interrupt service routines. Use *STB? in other cases (not in interrupt service routine) when you want to know the value of Status Byte.

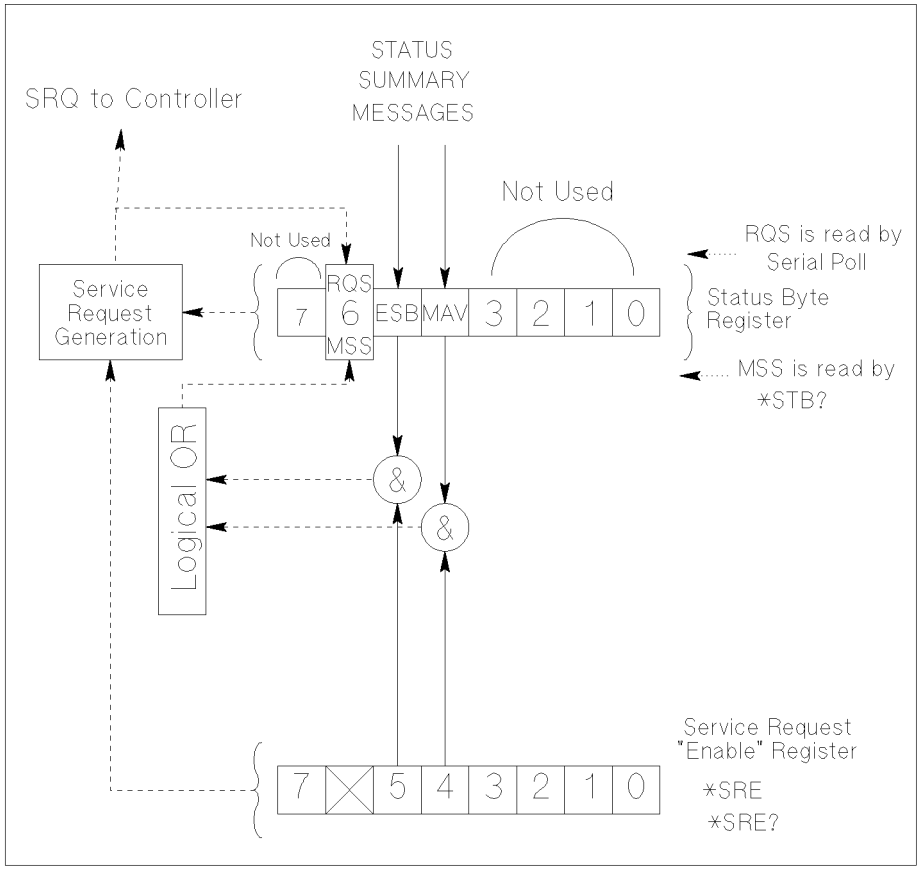
Table 5-1 Status Byte Register of B2200

Bit	Definition	Explanation
0	Not Used.	Always zero.
1	Not Used.	Always zero.
2	Not Used.	Always zero.
3	Not Used.	Always zero.
4	Message Available (MAV) Queue Summary Message	Indicates whether Output Queue is empty. If unread message exists, this bit is set to 1. Otherwise, this bit is set to 0. See “Output Queue” on page 5-60.
5	Standard Event Status Bit (ESB) Summary Message	Indicates whether one or more of the enabled Standard Events Status Register bits is set.
6	Request Service (RQS) Message	Indicates whether a SRQ (Service Request) has occurred. Read by Serial Poll.
	Master Summary Status (MSS) Summary Message	Indicates that the instrument has at least one reason for requesting service. Read by *STB?.
7	Not Used.	Always zero.

Service Request Enable Register

The Service Request Enable Register is an 8-bit register that can be used by the programmer to select which summary messages in the Status Byte Register may cause service requests. See Figure 5-3.

Figure 5-3 **Service Request Enable Register of B2200**

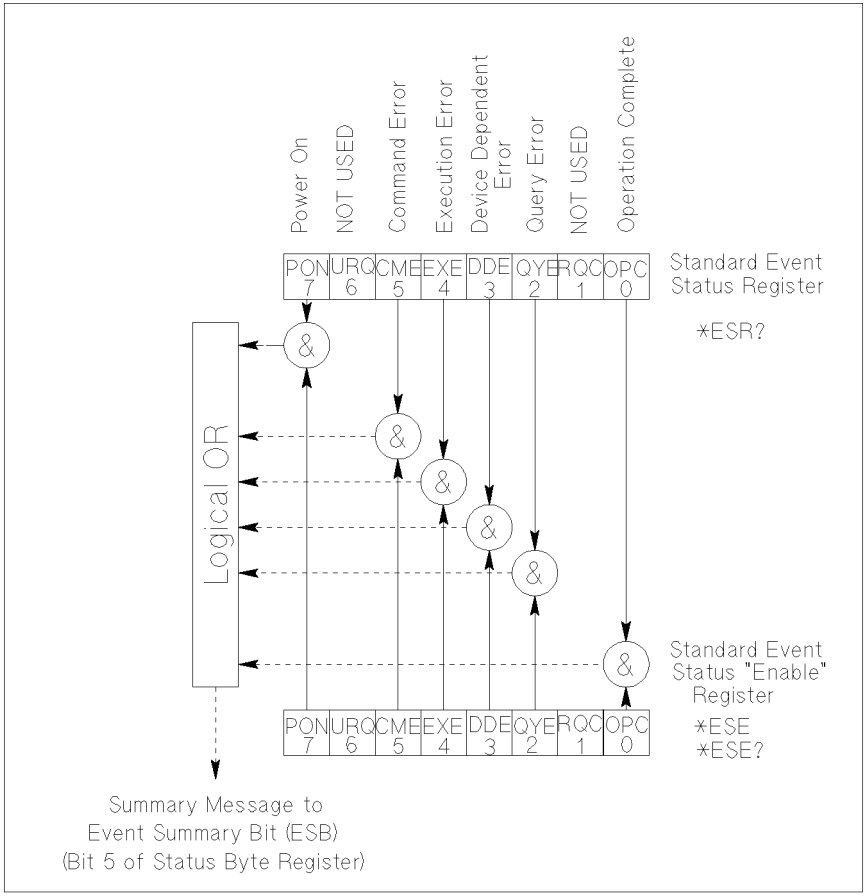


PG04003 120x120

Standard Event Status Register

The Standard Event Status Register has specific events assigned to specific bits. See Figure 5-4 and Table 5-2.

Figure 5-4 **Standard Event Status Register of B2200**



pg04004 100x100

Table 5-2 **Standard Event Status Register of B2200**

Bit	Definition	Explanation
0	Operation Complete (OPC)	This event bit has meaning only if a request to monitor is set by the *OPC command. See “*OPC” on page 5-8. This bit is set to `1` if there are no pending operations.
1	Not Used	Always 0.
2	Query Error (QYE)	• An attempt is being made to read data from the Output Queue when no data is present or pending. • Data in the Output Queue has been lost.
3	Device Dependent Error (DDE)	This event bit indicates that an error has occurred which is not a Command Error, a Query Error, or an Execution Error.
4	Execution Error (EXE)	Syntax of command is correct, but cannot be executed due to some condition of the B2200.
5	Command Error (CME)	A command syntax error has been detected.
6	Not Used	Always 0.
7	Power On (PON)	This event bit indicates that an off-to-on transition has occurred in instrument's power supply.
8 to 15	Not used	Always 0.

Standard Event Status Enable Register

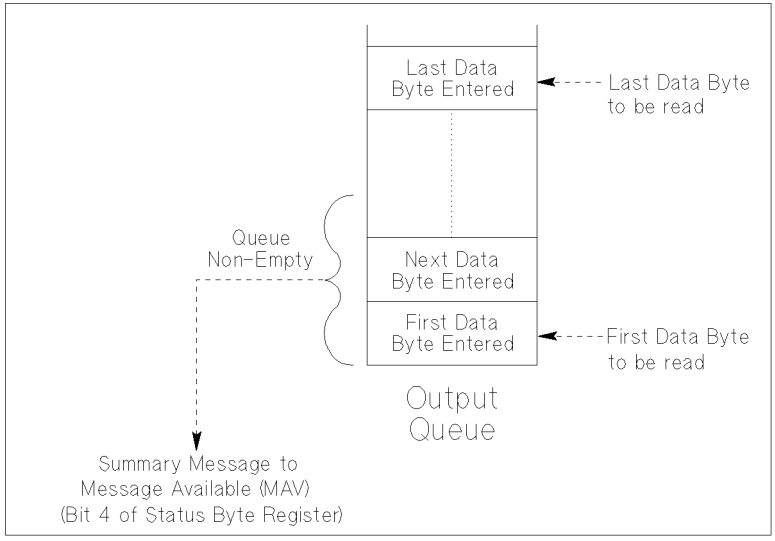
The Standard Event Status “Enable” Register is an 8-bit register that can be used by the programmer to select which bits of Standard Event Status Register are enabled. The status of the enabled bits are ORed together, and result of OR will be reported to the ESB bit (Bit5) of the Status Byte Register.

The 8 bits of this register correspond to the 8 bits of the Standard Event Status Register. See Figure 5-4.

Output Queue

The Output Queue stores response messages until they are read. If an unread message exists, Bit4 (Message Available – MAV) of the Status Byte Register is set to 1. So, Bit4 is used to synchronize information exchange with the controller. See Figure 5-5.

Figure 5-5 **Output Queue of B2200**



The Response Formatter places Data Byte Messages and END messages into the Output Queue in response to query commands. These messages are removed from the Output Queue as they are read by the controller. As long as the Output Queue contains an unread message, MAV is 1.

6 VXI plug&play Driver

This chapter introduces the VXI plug&play driver available for Agilent B2200, and consists of the following sections:

- “System Requirements”
- “Installing VXIplug&play Driver”
- “Driver Functions”

System Requirements

The following system environments are required.

- Operating System

  Microsoft Windows XP Professional, Windows 2000, Windows NT 4.0, or Windows 95. It must be supported by the application development environment.

- Application Development Environment (programming environment)

  Microsoft Visual Basic, Microsoft Visual C++, Borland C++Builder, National Instruments LabWindows or LabVIEW, or Agilent VEE.

- Agilent T&M Programmers Toolkit for Visual Studio .NET

  Agilent W1140A or equivalent. Needed for Visual Basic .NET users.

- GPIB (IEEE 488) Interface and 32-bit VISA I/O Library

  Agilent 82357A USB/GPIB interface, E5810A LAN/GPIB gateway, 82350B GPIB interface, or equivalent. These models include Agilent VISA and SICL I/O libraries.

- Computer and peripherals

  Required specifications depend on the application development environment. See manual of the application development environment. The flexible disk drive is required to install the VXI*plug&play* driver. The CD-ROM drive is required to install the software needed to use driver.

- Minimum disk space

  1 MB for the Agilent B2200 VXI*plug&play* driver

Installing VXI*plug&play* Driver

The installation flow is shown below. If you have already installed the GPIB interface card, VISA I/O library, and programming software on your PC, skip steps 1 through 5.

1. Install the GPIB interface card into your PC.

   See the interface card manual. Note the model number of the interface card, as you may need it to configure the interface (in step 3).

2. Install VISA I/O library.

   Follow the instructions in the I/O library's setup program.

3. Configure and check the GPIB interface.

   See the I/O library manual.

4. Install the programming software.

   Follow the setup program instructions.

5. If you use Microsoft Visual Basic .NET, install the Agilent T&M Programmers Toolkit.

6. Install the VXI*plug&play* driver as shown below.

   a. Insert the Agilent B2200 Plug&Play Driver Disk into the flexible disk drive connected to your PC.

   b. Execute the SETUP.EXE program on the diskette. The program automatically installs the following files.

      Directory: \Program Files\VISA\win*xx*\agb220xa (*xx* depends on OS)

      - agb220xa.bas
      - agb220xa.c
      - agb220xa.def
      - agb220xa.fp
      - agb220xa.GID
      - agb220xa.h
      - agb220xa.hlp
      - readme.txt
      - DelsL1.isu

Driver Functions

Table 6-1 lists all the functions for the Agilent B2200. You will see a brief description of the functions in the table.

For the description, syntax and parameters of the function, refer to the reference section following this table. The driver functions in the reference section will appear in the alphabetical order.

Table 6-1 Agilent B2200 Driver Function Lists

Category	Function	Description
Miscellaneous	agb220xa_init	Initializes the B2200.
	agb220xa_close	Closes the connection with the B2200.
	agb220xa_reset	Executes the B2200 reset.
	agb220xa_self_test	Executes the B2200 self-test.
	agb220xa_error_query	Queries for the B2200 error code/message.
	agb220xa_error_message	Queries for the driver error.
	agb220xa_revision_query	Queries for the B2200 firmware/driver revisions.
	agb220xa_timeOut	Sets the timeout.
	agb220xa_timeOut_Q	Queries for the timeout setting.
	agb220xa_errorQueryDetect	Sets the automatic error checking.
	agb220xa_errorQueryDetect_Q	Queries for the automatic error checking setting.
	agb220xa_dcl	Sends the Device Clear.
	agb220xa_esr_Q	Queries for the ESR status.
	agb220xa_readStatusByte_Q	Reads the B2200 status byte.
	agb220xa_opc_Q	Checks the B2200 operation completion status.
Mode Control	agb220xa_func	Sets the configuration mode.
	agb220xa_connRuleSeq	Sets the connection rule/sequence.
Couple Mode	agb220xa_couplePort	Selects the couple ports of the specified card.
	agb220xa_coupleState	Sets the couple mode ON or OFF for the specified card.
	agb220xa_detectCouplePort	Detects and sets the couple ports for all cards.
Bias Mode	agb220xa_biasPort	Selects the input bias port of the specified card.
	agb220xa_biasChanCard	Bias-enables all output ports of the specified card.
	agb220xa_biasChanList	Bias-enables all output ports of the specified channel list.
	agb220xa_biasState	Sets the bias mode ON or OFF for the specified card.
	agb220xa_biasChanList_Q	Queries for the bias channel list.

Category	Function	Description
Ground Mode	agb220xa_groundPort	Selects the input ground port of the specified card.
	agb220xa_groundChanCard	Ground-enables all output ports of the specified card.
	agb220xa_groundChanList	Ground-enables all output ports of the specified channel list.
	agb220xa_unusedPort	Ground-enables the specified input ports of the specified card.
	agb220xa_groundState	Sets the ground mode ON or OFF for the specified card.
	agb220xa_groundChanList_Q	Queries for the ground channel list.
Route Control	agb220xa_closeList	Closes the channel list.
	agb220xa_openList	Opens the channel list.
	agb220xa_openCard	Opens all output on the card.
	agb220xa_closeList_Q	Queries for the channel list status.
	agb220xa_openList_Q	
	agb220xa_closeCard_Q	Queries for the closed channel list on the card.
C/G Compensation	agb220xa_compenC	Performs the compensation for the C/G data measured by the Agilent 4284A.
	agb220xa_selectCompenFile	Selects the compensation data file used by the agb220xa_compenC function.
Diagnostics	agb220xa_testExec_Q	Performs diagnostics and returns the test result.
	agb220xa_testClear	Clears the specified test result.
Passthrough Functions	agb220xa_cmd	Sends a command.
	agb220xa_cmdInt	Sends a command with an integer parameter.
	agb220xa_cmdReal	Sends a command with a real parameter.
	agb220xa_cmdData_Q	Sends a command to read any data.
	agb220xa_cmdString_Q	Sends a command to read string response.
	agb220xa_cmdInt16_Q	Sends a command to read 16 bit integer response.
	agb220xa_cmdInt16Arr_Q	Sends a command to read 16 bit integer array response.
	agb220xa_cmdInt32_Q	Sends a command to read 32 bit integer response.
	agb220xa_cmdInt32Arr_Q	Sends a command to read 32 bit integer array response.
	agb220xa_cmdReal64_Q	Sends a command to read 64 bit real response.
	agb220xa_cmdReal64Arr_Q	Sends a command to read 64 bit real array response.

agb220xa_biasChanCard

This function bias-enables or disables all the output ports of the specified card.

Syntax

ViStatus _VI_FUNC agb220xa_biasChanCard(ViSession vi,
ViInt16 disable_enable, ViInt16 bias_cardno);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
disable_enable	Status of the card, bias enabled or bias disabled. 0 : sets bias enabled card. 1 : sets bias disabled card.
bias_cardno	Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the auto configuration mode). For the configuration mode, see agb220xa_func.

agb220xa_biasChanList

This function bias-enables or disables all the output ports specified by the biaschan_list.

The parameter “biaschan_list” is an array of integers with each integer representing one channel. The last number of the “biaschan_list” should be “0” (numeric zero) to identify the end of the list. The maximum number of channels that can be specified by the list is 100.

Syntax

ViStatus _VI_FUNC agb220xa_biasChanList(ViSession vi,
ViInt16 biaschan_disen, ViInt32_VI_FAR biaschan_list[ ]);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
biaschan_disen	Status of the port, bias enabled or bias disabled. 0 : sets bias enabled port. 1 : sets bias disabled port.
biaschan_list[ ]	Channel numbers. 5 digits integer. ABCDE. where A: card number, BC: input port number, DE: output port number. Top zero(s) can be ignored. For example, if A=0, BC=01, and DE=01, channel number should be 101 instead of 00101.

agb220xa_biasChanList_Q

This function will query the instrument for the status, bias enabled or bias disabled, for the channels given in the list.

The parameter “biaschan_list” is an array of integers with each integer representing one channel. The last number of the “biaschan_list” should be “0” (numeric zero) to identify the end of the list. The maximum number of channels that can be specified by the list is 100.

The “bias_status” parameter is an array of integers containing the return values of the query. The “bias_status” array returned will correspond one to one with “biaschan_list” parameter.

Syntax

ViStatus _VI_FUNC agb220xa_biasChanList_Q(ViSession vi, ViInt16 bias_disen, ViInt32_VI_FAR biaschan_list[ ], ViInt32_VI_FAR bias_status[ ]);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
bias_disen	Query type. 0 : checks if the port is the bias enabled. 1 : checks if the port is the bias disabled.
biaschan_list[ ]	Channel numbers to check the status. 5 digits integer. ABCDE. where A: card number, BC: input port number, DE: output port number. Top zero(s) can be ignored. For example, if A=0, BC=01, and DE=01, channel number should be 101 instead of 00101.
bias_status[ ]	Status of the channels given in the biaschan_list. Returned value depends on the setting of bias_disen as shown below: when bias_disen=0, 0 means bias disabled, 1 means enabled. when bias_disen=1, 0 means bias enabled, 1 means disabled.

agb220xa_biasPort

This function will select which input port is the bias port on the specified card. For each card, you can specify the same or different bias port.

Syntax

ViStatus _VI_FUNC agb220xa_biasPort(ViSession vi, ViInt16 bport_cardno, ViInt16 bias_port);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
bport_cardno	Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the auto configuration mode). For the configuration mode, see agb220xa_func.
bias_port	Input port number to be set to the bias port. 1 to 14 (input port 1 to input port 14).

If the bias input port and a couple port have been assigned to the same input port, the bias mode and the couple mode cannot be used in parallel.

agb220xa_biasState

This function controls the bias mode for the specified card. When bias mode is ON, the input bias port is connected to all bias enabled output ports that are not connected to any other input ports. Bias disabled output ports are never connected to the input bias port when bias mode is ON.

The bias mode cannot be set to ON when the ground mode is ON.

Syntax

ViStatus _VI_FUNC agb220xa_biasState(ViSession vi, ViInt16 bstate_cardno, ViInt16 state);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
bstate_cardno	Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the auto configuration mode). For the configuration mode, see agb220xa_func.
state	Bias mode. 0 (OFF) or 1 (ON).

agb220xa_close

This function terminates the software connection to the instrument and deallocates system resources. It is generally a good programming habit to close the instrument handle when the program is done using the instrument.

Syntax

ViStatus _VI_FUNC agb220xa_close(ViSession vi);

Parameters

vi	Instrument handle returned from agb220xa_init( ).

agb220xa_closeCard_Q

This function will query the card for the channels closed of the specified card.

The parameter “closechan_list” contains the channel numbers returned by the instrument. This will be an array of integers terminated by “zero” to identify the end of the list. Array of enough length should be passed to the function.

Syntax

ViStatus _VI_FUNC agb220xa_closeCard_Q(ViSession vi, ViInt16 close_card, ViInt32_VI_FAR closechan_list[ ]);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
close_card	Card number. 1 (card 1), 2 (card 2), 3 (card 3), or 4 (card 4) in the normal configuration mode, or 0 (all card in the auto configuration mode). For the configuration mode, see agb220xa_func.
closechan_list[ ]	Channels closed of the specified card.

agb220xa_closeList

This function will connect the input ports to the output ports specified by the channel list.

The parameter “closechan_list” is an array of integers with each integer representing one channel. The last number of the “closechan_list” should be “0” (numeric zero) to identify the end of the list. The maximum number of channels that can be specified by the list is 100.

Syntax

ViStatus _VI_FUNC agb220xa_closeList(ViSession vi,
ViInt32_VI_FAR closechan_list[ ]);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
closechan_list[ ]	Channel numbers to connect. 5 digits integer. ABCDE. where A: card number, BC: input port number, DE: output port number. Top zero(s) can be ignored. For example, if A=0, BC=01, and DE=01, channel number should be 101 instead of 00101.

agb220xa_closeList_Q

This function will query the instrument for the channels closed given in the “closechan_list”.

The parameter “closechan_list” is an array of integers with each integer representing one channel. The last number of the “closechan_list” should be “0” (numeric zero) to identify the end of the list. The maximum number of channels that can be specified by the list is 100.

The “close_status” parameter is an array of integers containing the return values of the query. The “close_status” array returned will correspond one to one with “closechan_list” parameter.

Syntax

ViStatus _VI_FUNC agb220xa_closeList_Q(ViSession vi, ViInt32_VI_FAR closechan_list[ ], ViInt32_VI_FAR close_status[ ]);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
closechan_list[ ]	Channel numbers to know the close status. 5 digits integer. ABCDE. where A: card number, BC: input port number, DE: output port number. Top zero(s) can be ignored. For example, if A=0, BC=01, and DE=01, channel number should be 101 instead of 00101.
close_status[ ]	Status of the channels given in the closechan_list. 0 (opened) or 1 (closed).

agb220xa_cmd

This function passes the cmd_str string to the instrument. Must be a NULL terminated C string.

Syntax

ViStatus _VI_FUNC agb220xa_cmd(ViSession vi, ViString cmd_str);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
cmd_str	Instrument command (cannot exceed 256 bytes in length).

agb220xa_cmdData_Q

This function passes the cmd_str string to the instrument. This entry point will wait for a response which may be any data. You specify the cmd_str and size parameters, and get result[ ].

Syntax

ViStatus _VI_FUNC agb220xa_cmdData_Q(ViSession vi, ViString cmd_str, ViInt32 size, ViChar_VI_FAR result[ ]);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
cmd_str	Instrument command (cannot exceed 256 bytes in length).
size	Length of result in bytes. 2 to 32767.
result[ ]	Response from instrument.

agb220xa_cmdInt

This function passes the cmd_str string to the instrument. This entry point passes the string in cmd_str followed by a space and then the integer in value. Note that either an Int16 or 32 can be passed as the Int16 will be promoted.

Syntax

ViStatus _VI_FUNC agb220xa_cmdInt(ViSession vi, ViString cmd_str, ViInt32 value);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
cmd_str	Instrument command (cannot exceed 256 bytes in length).
value	Parameter for command. -2147483647 to 2147483647.

agb220xa_cmdInt16Arr_Q

This function passes the cmd_str string to the instrument. This command expects a response that is a definite arbitrary block of 16 bit integers. You specify the cmd_str and size parameters, and get result[ ] and count.

Syntax

ViStatus _VI_FUNC agb220xa_cmdInt16Arr_Q(ViSession vi, ViString cmd_str, ViInt32 size, ViInt16_VI_FAR result[ ], ViPInt32 count);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
cmd_str	Instrument command (cannot exceed 256 bytes in length).
size	Size of result[ ] (number of items in the array). 1 to 2147483647.
result[ ]	Response from instrument.
count	Count of valid items in result[ ].

agb220xa_cmdInt16_Q

This function passes the cmd_str string to the instrument. This command expects a response that can be returned as a 16 bit integer.

Syntax

ViStatus _VI_FUNC agb220xa_cmdInt16_Q(ViSession vi, ViString cmd_str, ViPInt16 result);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
cmd_str	Instrument command (cannot exceed 256 bytes in length).
result	Response from instrument.

agb220xa_cmdInt32Arr_Q

This function passes the cmd_str string to the instrument. This command expects a response that is a definite arbitrary block of 32 bit integers. You specify the cmd_str and size parameters, and get result[ ] and count.

Syntax

ViStatus _VI_FUNC agb220xa_cmdInt32Arr_Q(ViSession vi, ViString cmd_str, ViInt32 size, ViInt32_VI_FAR result[ ], ViPInt32 count);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
cmd_str	Instrument command (cannot exceed 256 bytes in length).
size	Size of result[ ] (number of items in the array). 1 to 2147483647.
result[ ]	Response from instrument.
count	Count of valid items in result[ ].

agb220xa_cmdInt32_Q

This function passes the cmd_str string to the instrument. This command expects a response that can be returned as a 32 bit integer.

Syntax

ViStatus _VI_FUNC agb220xa_cmdInt32_Q(ViSession vi, ViString cmd_str, ViPInt32 result);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
cmd_str	Instrument command (cannot exceed 256 bytes in length).
result	Response from instrument.

agb220xa_cmdReal

This function passes the cmd_str string to the instrument. This entry point passes the string in cmd_str followed by a space and then the real in value. Note that either an Real32 or 64 can be passed as the Real32 will be promoted.

Syntax

ViStatus _VI_FUNC agb220xa_cmdReal(ViSession vi, ViString cmd_str, ViReal64 value);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
cmd_str	Instrument command (cannot exceed 256 bytes in length).
value	Parameter for command. -1E+300 to 1E+300.

agb220xa_cmdReal64Arr_Q

This function passes the cmd_str string to the instrument. This command expects a response that is a definite arbitrary block of 64 bit real. You specify the cmd_str and size parameters, and get result[ ] and count.

Syntax

ViStatus _VI_FUNC agb220xa_cmdReal64Arr_Q(ViSession vi, ViString cmd_str, ViInt32 size, ViReal64_VI_FAR result[ ], ViPInt32 count);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
cmd_str	Instrument command (cannot exceed 256 bytes in length).
size	Size of result[ ] (number of items in the array). 1 to 2147483647.
result[ ]	Response from instrument.
count	Count of valid items in result[ ].

agb220xa_cmdReal64_Q

This function passes the cmd_str string to the instrument. This command expects a response that can be returned as a 64 bit real.

Syntax

ViStatus _VI_FUNC agb220xa_cmdReal64_Q(ViSession vi, ViString cmd_str, ViPReal64 result);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
cmd_str	Instrument command (cannot exceed 256 bytes in length).
result	Response from instrument.

agb220xa_cmdString_Q

This function passes the cmd_str string to the instrument. This entry point will wait for a response which must be a string (character data). You specify the cmd_str and size parameters, and get result[ ].

Syntax

ViStatus _VI_FUNC agb220xa_cmdString_Q(ViSession vi, ViString cmd_str, ViInt32 size, ViChar_VI_FAR result[ ]);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
cmd_str	Instrument command (cannot exceed 256 bytes in length).
size	Length of result in bytes. 2 to 32767.
result[ ]	Response from instrument.

agb220xa_compenC

This function compensates capacitance/conductance data measured by the Agilent 4284A LCR meter, and returns compensation results. Before this function is executed, a compensation data file must be specified by using the agb220xa_selectCompenFile function. The file must contain the appropriate compensation coefficients for your measurement environment. For obtaining the compensation coefficients for your environment and creating the compensation data file, see “Capacitance Compensation” on page 4-20.

Syntax

agb220xa_compenC(ViSession vi, ViReal64 frequency, ViReal64 raw_c, ViReal64 raw_g, ViPReal64 compen_c, ViPReal64 compen_g);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
frequency	Measurement frequency (in Hz). 1E3 (1 kHz) to 1E6 (1 MHz).
raw_c	Capacitance (in F) measured by the 4284A.
raw_g	Conductance (in S) measured by the 4284A.
compen_c	Capacitance compensation result (in F). Returned value.
compen_g	Conductance compensation result (in S). Returned value.

agb220xa_connRuleSeq

The function sets connection rule and connection sequence for the specified card.

Syntax

ViStatus _VI_FUNC agb220xa_connRuleSeq(ViSession vi, ViInt16 cardno_ruleseq, ViInt16 rule, ViInt16 sequence);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
cardno_ruleseq	Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the auto configuration mode). For the configuration mode, see agb220xa_func.
rule	Connection rule. 0 (free route) or 1 (single route).
sequence	Connection sequence. 0, 1, or 2. See below.
	0 (no sequence)
	1 (break before make)
	2 (make before break)

agb220xa_couplePort

This function sets the couple ports which are used for making kelvin connections on the specified card. The specified input port number will be coupled with the next input port and two output ports. For each card, you may setup the same or different couple ports. This command overwrites the previous couple port setting for the card.

The couple mode is controlled by the agb220xa_coupleState function.

If the bias input port and a couple port have been assigned to the same input port, the bias mode and the couple mode cannot be used in parallel.

If the ground input port and a couple port have been assigned to the same input port, the ground mode and the couple mode cannot be used in parallel.

If a ground enabled input port and a couple port have been assigned to the same input port, the ground mode and the couple mode cannot be used in parallel.

Syntax

ViStatus _VI_FUNC agb220xa_couplePort(ViSession vi, ViInt16 cport_cardno, ViInt16 port1, ViInt16 port3, ViInt16 port5, ViInt16 port7, ViInt16 port9, ViInt16 port11, ViInt16 port13);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
cport_cardno	Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the auto configuration mode). For the configuration mode, see agb220xa_func.
port1	Couple port by the input ports 1 and 2. 0 (disable) or 1 (enable).
port3	Couple port by the input ports 3 and 4. 0 (disable) or 1 (enable).
port5	Couple port by the input ports 5 and 6. 0 (disable) or 1 (enable).
port7	Couple port by the input ports 7 and 8. 0 (disable) or 1 (enable).
port9	Couple port by the input ports 9 and 10. 0 (disable) or 1 (enable).
port11	Couple port by the input ports 11 and 12. 0 (disable) or 1 (enable).

port13 Couple port by the input ports 13 and 14. 0 (disable) or 1 (enable).

agb220xa_coupleState

This function controls the couple mode for the specified card.

Syntax ViStatus _VI_FUNC agb220xa_coupleState(ViSession vi, ViInt16 cstate_cardno, ViInt16 couple_state);

Parameters

vi Instrument handle returned from agb220xa_init( ).

cstate_cardno Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the auto configuration mode). For the configuration mode, see agb220xa_func.

couple_state Couple mode. 0 (OFF) or 1 (ON).

agb220xa_dcl

This function sends a device clear (DCL) to the instrument.

A device clear will abort the present operation and enable the instrument to accept a new command or query.

This is particularly useful in situations where it is not possible to determine the instrument state. In this case, it is customary to send a device clear before issuing a new instrument driver function. The device clear ensures that the instrument will be able to begin processing the new commands.

Syntax ViStatus _VI_FUNC agb220xa_dcl(ViSession vi);

Parameters

vi Instrument handle returned from agb220xa_init( ).

agb220xa_detectCouplePort

This function detects the input ports connected to the Kelvin cable, and assigns them as the input couple ports that will be used for the Kelvin connection. The input couple port setting is effective for the all cards. This command overwrites the previous couple port setting.

Syntax ViStatus _VI_FUNC agb220xa_detectCouplePort(ViSession vi);

Parameters

vi	Instrument handle returned from agb220xa_init( ).

agb220xa_error_message

This function translates the error return value from an instrument driver function to a readable string.

Syntax

ViStatus _VI_FUNC agb220xa_error_message(ViSession vi, ViStatus error_number, ViChar_VI_FAR message[ ]);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
error_number	Error return value from the driver function.
message[ ]	Error message string. This is limited to 256 characters.

agb220xa_error_query

This function returns the error numbers and corresponding error messages in the error queue of a instrument. See Chapter 9 for a listing of the instrument error numbers and messages.

Instrument errors may occur when you places the instrument in a bad state such as sending an invalid sequence of coupled commands. Instrument errors can be detected by polling. Automatic polling can be accomplished by using the agb220xa_errorQueryDetect function.

Syntax

ViStatus _VI_FUNC agb220xa_error_query(ViSession vi, ViPInt32 error_number, ViChar_VI_FAR error_message[ ]);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
error_number	Instrument's error code.
error_message[ ]	Instrument's error message. This is limited to 256 characters.

agb220xa_errorQueryDetect

This function enables or disables automatic instrument error checking.

If automatic error checking is enabled then the driver will query the instrument for an error at the end of each function call.

Syntax

ViStatus _VI_FUNC agb220xa_errorQueryDetect(ViSession vi, ViBoolean errorQueryDetect);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
errorQueryDetect	Error checking enable (VI_TRUE) or disable (VI_FALSE).

agb220xa_errorQueryDetect_Q

This function indicates if automatic instrument error detection is enabled or disabled.

Syntax

ViStatus _VI_FUNC agb220xa_errorQueryDetect_Q(ViSession vi, ViPBoolean pErrDetect);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
pErrDetect	Error checking enable (VI_TRUE) or disable (VI_FALSE).

agb220xa_esr_Q

This function returns the contents of the ESR register. The driver returns the equivalent messages (see Parameters).

Syntax

ViStatus _VI_FUNC agb220xa_esr_Q(ViSession vi, ViChar_VI_FAR errstr[ ]);

Parameters

vi Instrument handle returned from agb220xa_init( ).

errstr[ ] Response from instrument.

Bit Value	Message
1	“ESR_OPC”
2	“ESR_RQL”
4	“ESR_QYE_ERROR”
8	“ESR_DEVICE_DEPENDENT_ERROR”
16	“ESR_EXECUTION_ERROR”
32	“ESR_COMMAND_ERROR”
64	“ESR_URQ”
128	“ESR_PON”
OTHERS	“ESR_MULTI_EVENT”

agb220xa_func

This function is used to set the channel configuration to the auto configuration mode or the normal configuration mode.

Syntax

ViStatus _VI_FUNC agb220xa_func(ViSession vi, ViInt16 channel_config);

Parameters

vi Instrument handle returned from agb220xa_init( ).

channel_config Configuration mode. 0 (auto) or 1 (normal).

agb220xa_groundChanCard

This function ground-enables or disables all the output ports of the specified card.

Syntax

ViStatus _VI_FUNC agb220xa_groundChanCard(ViSession vi,
ViInt16 disable_enable, ViInt16 gnd_cardno);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
disable_enable	Status of the card, ground enabled or ground disabled. 0 : sets ground enabled card. 1 : sets ground disabled card.
gnd_cardno	Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the auto configuration mode). For the configuration mode, see agb220xa_func.

agb220xa_groundChanList

This function ground-enables or disables all the output ports specified by the gndchan_list.

The parameter “gndchan_list” is an array of integers with each integer representing one channel. The last number of the “gndchan_list” should be “0” (numeric zero) to identify the end of the list. The maximum number of channels that can be specified by the list is 100.

Syntax

ViStatus _VI_FUNC agb220xa_groundChanList(ViSession vi,
ViInt16 gndchan_disen, ViInt32_VI_FAR gndchan_list[ ]);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
gndchan_disen	Status of the port, ground enabled or ground disabled. 0 : sets ground enabled port. 1 : sets ground disabled port.
gndchan_list[ ]	Channel numbers. 5 digits integer. ABCDE. where A: card number, BC: input port number, DE: output port number. Top zero(s) can be ignored. For example, if A=0, BC=01, and DE=01, channel number should be 101 instead of 00101.

agb220xa_groundChanList_Q

This function will query the instrument for the status, ground enabled or disabled, for the channels given in the list.

The parameter “gndchan_list” is an array of integers with each integer representing one channel. The last number of the “gndchan_list” should be “0” (numeric zero) to identify the end of the list. The maximum number of channels that can be specified by the list is 100.

The “gnd_status” parameter is an array of integers containing the return values of the query. The “gnd_status” array returned will correspond one to one with “gndchan_list” parameter.

Syntax

ViStatus _VI_FUNC agb220xa_groundChanList_Q(ViSession vi, ViInt16 gnd_disen, ViInt32_VI_FAR gndchan_list[ ], ViInt32_VI_FAR gnd_status[ ]);

Parameters

vi Instrument handle returned from agb220xa_init( ).

gnd_disen Query type.

0 : checks if the port is the ground enabled.

1 : checks if the port is the ground disabled.

gndchan_list[ ] Channel numbers to check the status. 5 digits integer. ABCDE. where A: card number, BC: input port number, DE: output port number. Top zero(s) can be ignored. For example, if A=0, BC=01, and DE=01, channel number should be 101 instead of 00101.

gnd_status[ ] Status of the channels given in the gndchan_list. Returned value depends on the setting of gnd_disen as shown below:

when gnd_disen=0, 0 means ground disabled, 1 means enabled.

when gnd_disen=1, 0 means ground enabled, 1 means disabled.

agb220xa_groundPort

This function will select which input port is the ground port on the specified card. For each card, you can specify the same or different ground port.

Syntax

ViStatus _VI_FUNC agb220xa_groundPort(ViSession vi, ViInt16 gport_cardno, ViInt16 gnd_port);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
gport_cardno	Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the auto configuration mode). For the configuration mode, see agb220xa_func.
gnd_port	Input port number to be set to the ground port. 1 to 14 (input port 1 to input port 14).

The input ground port and a ground enabled input port cannot be assigned to the same input port.

If the ground input port and a couple port have been assigned to the same input port, the ground mode and the couple mode cannot be used in parallel.

agb220xa_groundState

This function controls the ground mode for the specified card. When ground mode is ON, the input ground port is connected to all ground enabled input ports and output ports that are not connected to any other input ports. Ground disabled output ports are never connected to the input ground port when ground mode is ON.

The ground mode cannot be set to ON when the bias mode is ON.

Syntax

ViStatus _VI_FUNC agb220xa_groundState(ViSession vi, ViInt16 gstate_cardno, ViInt16 state);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
gstate_cardno	Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the auto configuration mode). For the configuration mode, see agb220xa_func.
state	Ground mode. 0 (OFF) or 1 (ON).

agb220xa_init

This function initializes the software connection to the instrument and optionally verifies that instrument is in the system. In addition, it may perform any necessary actions to place the instrument in its reset state.

If the agb220xa_init function encounters an error, then the value of the vi output parameter will be VI_NULL.

Syntax

ViStatus _VI_FUNC agb220xa_init(ViRsrc InstrDesc, ViBoolean id_query, ViBoolean do_reset, ViPSession vi);

Parameters

InstrDesc	Instrument description. Examples; GPIB0::1::INSTR.
id_query	VI_TRUE (to perform In-System Verification), or VI_FALSE (do not perform In-System Verification).
do_reset	VI_TRUE (to perform reset operation), or VI_FALSE (do not perform reset operation).
vi	Instrument handle. This is VI_NULL if an error occurred during the initialization.

agb220xa_opc_Q

This function does the *OPC? common command.

Syntax

ViStatus _VI_FUNC agb220xa_opc_Q(ViSession vi, ViPBoolean result);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
result	VI_TRUE (Operation complete), or VI_FALSE (Operation is pending).

agb220xa_openCard

This function will disconnect all input ports from all output ports for the specified card.

If bias mode is ON, the input bias port is connected to all bias enabled output ports.

If ground mode is ON, the input ground port is connected to all ground enabled input ports and output ports.

Syntax

ViStatus _VI_FUNC agb220xa_openCard(ViSession vi, ViInt16 open_cardno);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
open_cardno	Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the auto configuration mode). For the configuration mode, see agb220xa_func.

agb220xa_openList

This function will disconnect the input ports from the output ports specified by the channel list.

The parameter “openchan_list” is an array of integers with each integer representing one channel. The last number of the “openchan_list” should be “0” (numeric zero) to identify the end of the list. The maximum number of channels that can be specified by the list is 100.

Syntax

ViStatus _VI_FUNC agb220xa_openList(ViSession vi,
ViInt32_VI_FAR openchan_list[ ]);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
openchan_list[ ]	Channel numbers to disconnect. 5 digits integer. ABCDE. where A: card number, BC: input port number, DE: output port number. Top zero(s) can be ignored. For example, if A=0, BC=01, and DE=01, channel number should be 101 instead of 00101.

agb220xa_openList_Q

This function will query the instrument for the channels open given in the “openchan_list”.

The parameter “openchan_list” is an array of integers with each integer representing one channel. The last number of the “openchan_list” should be “0” (numeric zero) to identify the end of the list. The maximum number of channels that can be specified by the list is 100.

The “open_status” parameter is an array of integers containing the return values of the query. The “open_status” array returned will correspond one to one with “openchan_list” parameter.

Syntax

ViStatus _VI_FUNC agb220xa_openList_Q(ViSession vi, ViInt32_VI_FAR openchan_list[ ], ViInt32_VI_FAR open_status[ ]);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
openchan_list[ ]	Channel numbers to know the open status. 5 digits integer. ABCDE. where A: card number, BC: input port number, DE: output port number. Top zero(s) can be ignored. For example, if A=0, BC=01, and DE=01, channel number should be 101 instead of 00101.
open_status[ ]	Status of the channels given in the openchan_list. 1 (opened) or 0 (closed).

agb220xa_readStatusByte_Q

This function returns the contents of the status byte register.

Syntax

ViStatus _VI_FUNC agb220xa_readStatusByte_Q(ViSession vi, ViPInt16 statusByte);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
statusByte	The contents of the status byte are returned in this parameter.

agb220xa_reset

This function places the instrument in a default state. Before issuing this function, it may be necessary to send a device clear to ensure that the instrument can execute a reset. A device clear can be issued by invoking agb220xa_dcl function.

Syntax

ViStatus _VI_FUNC agb220xa_reset(ViSession vi);

Parameters

vi	Instrument handle returned from agb220xa_init( ).

agb220xa_revision_query

This function returns the driver revision and the instrument firmware revision.

Syntax

ViStatus _VI_FUNC agb220xa_revision_query(ViSession vi,
ViChar_VI_FAR driver_rev[ ] , ViChar_VI_FAR instr_rev[ ]);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
driver_rev[ ]	Instrument driver revision. This is limited to 256 characters.
instr_rev[ ]	Instrument firmware revision. This is limited to 256 characters.

agb220xa_selectCompenFile

This function specifies the compensation data file used by the agb220xa_compenC function. The file must contain the appropriate compensation coefficients for your measurement environment.

For obtaining the compensation coefficients for your environment and creating the compensation data file, see “Capacitance Compensation” on page 4-20.

Syntax

ViStatus _VI_FUNC agb220xa_selectCompenFile(ViSession vi,
ViString file_name);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
file_name	Compensation data file name. Use absolute path. If the value is NULL string, the default data is used.

agb220xa_self_test

This function causes the instrument to perform a self-test and returns the result of that self-test. This is used to verify that an instrument is operating properly. A failure may indicate a potential hardware problem.

Syntax

ViStatus _VI_FUNC agb220xa_self_test(ViSession vi, ViPInt16 test_result, ViChar_VI_FAR test_message[ ]);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
test_result	Numeric result from self-test operation. 0: No error.
test_message[ ]	Self-test status message. This is limited to 256 characters.

agb220xa_testClear

This function clears the test result of the specified diagnostics item.

Syntax

ViStatus _VI_FUNC agb220xa_testClear(ViSession vi, ViInt16 framecard_clear);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
framecard_clear	Test result to clear. 0 to 10. See below.
	0: Test result of all test items
	1: Card 1 relay test result
	2: Card 2 relay test result
	3: Card 3 relay test result
	4: Card 4 relay test result
	5: Relay test result of all cards
	6: Front panel key test result
	7: Controller test result
	8: Light pen test result
	9: LED matrix test result
	10: Beeper test result

agb220xa_testExec_Q

This function performs the diagnostics and returns the test result.

For details of each test, see “Selftest Menu” on page 3-34.

Syntax

ViStatus _VI_FUNC agb220xa_testExec_Q(ViSession vi, ViInt16 framecard_exec, ViPInt16 exec_result);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
framecard_exec	Test item to perform. 1 to 10. See below.
	1: Card 1 relay test
	2: Card 2 relay test
	3: Card 3 relay test
	4: Card 4 relay test
	5: Relay test of all cards
	6: Front panel key test
	7: Controller test
	8: Light pen test
	9: LED matrix test
	10: Beeper test
exec_result	Test result. 0: pass, 1: fail.

agb220xa_timeOut

This function sets a minimum timeout value for driver I/O transactions in milliseconds. The default timeout period is 2 seconds.

Syntax

ViStatus_VI_FUNC agb220xa_timeOut(ViSession vi, ViInt32 timeOut);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
timeOut	I/O timeout value for all functions in the driver. in milliseconds. 0 to 2147483647.

agb220xa_timeOut_Q

This function returns the timeout value for driver I/O transactions in milliseconds.

Syntax

ViStatus_VI_FUNC agb220xa_timeOut_Q(ViSession vi, ViPInt32 pTimeOut);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
pTimeOut	Minimum timeout period that the driver can be set to, in milliseconds.

agb220xa_unusedPort

This function ground-enables the specified input ports of the specified card.

The parameter “unused_port” is an array of integers with each integer representing one port. The last number of the “unused_port” should be “0” (numeric zero) to identify the end of the array. The maximum number of ports that can be specified by the array is agb220xa_UNUSEDPORT_MAX.

Syntax

ViStatus _VI_FUNC agb220xa_unusedPort(ViSession vi, ViInt16 unused_cardno, ViInt32_VI_FAR unused_port[ ]);

Parameters

vi	Instrument handle returned from agb220xa_init( ).
unused_cardno	Card number. 1 (card 1), 2 (card 2), 3 (card 3), 4 (card 4), or 5 (all card) in the normal configuration mode, or 0 (all card in the auto configuration mode). For the configuration mode, see agb220xa_func.
unused_port[ ]	Input ports to be ground enabled. 1 to 9 are available. Multiple port numbers can be set.

The input ground port and a ground enabled input port cannot be assigned to the same input port.

If the ground enabled input port and a couple port have been assigned to the same input port, the ground mode and the couple mode cannot be used in parallel.

NOTE

The ground enabled input ports are connected to the input ground port when the ground mode is ON. So the ground enabled input connectors must be opened to prevent the instrument from damage.

7 Error Messages

This chapter lists and describes the error messages for Agilent B2200. An error message consists of an error number and message.

There are two types of error messages:

- Standard SCPI Error Messages

  Negative error numbers (Command Error, Execution Error, Device-Dependent Error, and Query Error) are standard SCPI errors.

- B2200 Specific Error Messages

  Positive error numbers are the B2200 specific errors.

Error messages are classified by error number as listed in the following table:

Error Range	Error Category
0	No error
-100 to -199	Command Error
-200 to -299	Execution Error
-300 to -399	Device-Dependent Error
-400 to -499	Query Error
100 to 32767	B2200 Specific Error

When an error occurs, the corresponding bit is set in the Standard Event Status Register (see Chapter 5):

Error Category	Standard Event Status Register Bit
Command Error	bit5
Execution Error	bit4
Device-Dependent Error	bit3
Query Error	bit2
B2200 Specific Error	bit3

Also, the error number and message are placed in the error queue, which can be read by the `:SYSTem:ERRor?` query command. The error queue is cleared by the common command `*CLS`, and when power is turned on. For these commands, see Chapter 5.

Standard SCPI Error Messages

Standard SCPI error messages have negative error numbers. The following are the standard SCPI error messages for the B2200:

Command Error

If syntax of SCPI command is *not* valid, a `-1`*XX* error occurs. The error number and message are placed in the error queue, and bit5 of the Standard Event Status Register is set.

A SCPI command consists of a **command header** and zero or more **parameters**. The following are example SCPI commands:

- Subsystem command: `:ROUT:OPEN:CARD 1`

  `:ROUT:OPEN:CARD` is the command header, and `1` is the parameter.

  A subsystem command header consists of mnemonics (keywords) separated by colons. Query commands have a question mark (`?`) at end of last mnemonic.

- Common command: `*SRE 48`

  `*SRE` is the command header, and `48` is the parameter.

  A common command header consists of an asterisk (`*`) followed by 3 characters. Query commands have a question mark (`?`) at end of header.

Error Number	Error Message and Description
-100	**Command error** Generic syntax error that cannot be determined more specifically.
-101	**Invalid character** A syntax element contains a character that is invalid for that type of element; for example, a header containing an ampersand.
-102	**Syntax error** An unrecognized command or data type was received; for example, a string was received when the B2200 does not accept strings.

Error Number	Error Message and Description
-103	**Invalid separator** An illegal character was received when a separator was expected; for example, the semicolon was omitted between multiple commands in a program message.
-104	**Data type error** An improper data type was received; for example, numeric data was expected but string data was received.
-105	**GET not allowed** A group execute trigger was received within a program message.
-108	**Parameter not allowed** Too many parameters for the command were received.
-109	**Missing parameter** Fewer parameters were received than required for the command.
-110	**Command header error** An error was detected in the header. This error message is reported if the B2200 cannot determine the more specific header errors -111 through -114.
-111	**Header separator error** An illegal character for a header separator was received; for example, no white space between the command header and parameter.
-112	**Program mnemonic too long** A keyword in the command header contains more than twelve characters.
-113	**Undefined header** An undefined command header was received; for example, `*XYZ` or `:ROUT:OPEN:COOD`.

Error Number	Error Message and Description
-120	**Numeric data error** An error was detected in a numeric parameter (including the non-decimal numeric types). This error message is reported when the B2200 cannot determine the more specific errors -121 through -128.
-121	**Invalid character in number** An invalid character for the parameter was received; for example, an alphacharacter was received when the parameter type was decimal numeric.
-123	**Exponent too large** The magnitude of the exponent for a numeric parameter was larger than 32000.
-124	**Too many digits** The mantissa of a decimal numeric parameter contained more than 255 digits excluding leading zeros.
-128	**Numeric data not allowed** Numeric data is not allowed in this position for this command.
-138	**Suffix not allowed** A suffix was received after a numeric parameter. For the B2200, no parameters have suffix.
-140	**Character data error** An error was detected in a character parameter. This error message is reported if the B2200 cannot determine the more specific errors -141 through -148.
-141	**Invalid character data** Either the character parameter contains an invalid character or the particular element received is not valid for the command.
-144	**Character data too long** The character parameter contains more than 12 characters.

Error Number	Error Message and Description
-148	**Character data not allowed** A character parameter is not allowed for this position.
-150	**String data error** An error was detected in a string parameter. This error is reported if the B2200 cannot determine a more specific error -151 and -158.
-151	**Invalid string data** An invalid string parameter data was received; for example, an END message was received before the terminal quote character.
-158	**String data not allowed** A string parameter data was received but was not allowed at this point.
-160	**Block data error** An error was detected in a block data. This error is reported if the B2200 cannot determine more specific errors -161 and -168.
-161	**Invalid block data** An invalid block data was received; for example, an END message was received before the length was satisfied.
-168	**Block data not allowed** A legal block data was received but was not allowed at this point.
-170	**Expression error** An error was detected in an expression. This error is reported if the B2200 cannot determine more specific errors -171 and -178.
-171	**Invalid expression** The expression was invalid; for example, unmatched parentheses or an illegal character.
-178	**Expression data not allowed** An expression was received but was not allowed at this point.

Execution Error

If syntax of a SCPI command header and parameter is valid, but the command cannot be executed due to some condition of the B2200, a -2*XX* error occurs. The error number and message are placed in the error queue, and bit4 of the Standard Event Status Register is set.

Error Number	Error Message and Description
-200	**Execution error** Generic execution error that cannot be determined more specifically.
-220	**Parameter error** The parameter value is valid, but not executable due to some condition of the B2200. This error occurs if more specific errors -221 through -224 cannot be determined.
-222	**Data out of range** A valid parameter setting could not be executed because interpreted value was out of range as defined by the B2200.
-223	**Too much data** A valid parameter setting (block, expression, or string type) could not be executed because parameter contained more data than the B2200 could handle due to insufficient memory or other requirements.
-224	**Illegal parameter value** A valid parameter setting (where exact value from list of possibles was expected) could not be executed due to present B2200 state.
-260	**Expression error** An expression related error occurred.

Device-Dependent Errors

-3*XX* errors indicate that an B2200 operation did not properly complete, possibly due to an abnormal hardware or firmware condition. These negative codes are SCPI defined. For the device-dependent positive error codes, see “B2200 Specific Error Messages” on page 7-10. The positive codes are not SCPI defined.

For these errors, an error number and message are placed in the error queue, and bit3 of the Standard Event Status Register is set.

Error Number	Error Message and Description
-300	**Device-specific error** Generic device-dependent error for the B2200 that cannot be determined more specifically.
-311	**Memory error** An error was detected in the B2200's memory.
-350	**Queue overflow** If error queue is full, this code is entered into the error queue instead of the code that caused the error. This code indicates that there was no room in the error queue, so an error occurred but was not recorded.

Query Errors

If the output queue control of the B2200 detects one of following problems, a -4*XX* error occurs:.

- An attempt was made to read data from the output queue when no output data is present or pending.
- Data in the output queue has been lost.

If this type of error occurs, the error number and message are placed in the error queue, and bit2 of the Standard Event Status Register is set.

Error Number	Error Message and Description
-400	**Query error** Generic query error for the B2200 that cannot be determined more specifically.
-410	**Query INTERRUPTED** A condition causing an INTERRUPTED query error occurred; for example, a query followed by DAB or GET before a response was completely sent.
-420	**Query UNTERMINATED** A condition causing an UNTERMINATED query error occurred; for example, the B2200 was addressed to talk and an incomplete program message was received.
-430	**Query DEADLOCKED** A condition causing a DEADLOCKED query error occurred; for example, both input buffer and output buffer are full and the B2200 cannot continue.
-440	**Query UNTERMINATED after indefinite response** A query was received in the same program message after a query requesting an indefinite length response was executed.

B2200 Specific Error Messages

These are the B2200-specific errors that are not defined by SCPI. These errors indicate that an B2200 operation did not properly complete due to card, channel, port, or mode errors.

For the SCPI defined device-dependent codes, see “Device-Dependent Errors” on page 7-8.

For these errors, an error number and message are placed in the error queue, and bit3 of the Standard Event Status Register is set.

The B2200 specific error messages have positive error numbers.

B2200 Channel Related Errors

Error Number	Error Message and Description
2000	**Invalid card number** Wrong card number is specified in card number or channel list parameter. Make sure card is properly installed in the correct B2200 slot.
2001	**Invalid channel number** Wrong channel number is specified in the channel list. Confirm the channel number, the card configuration, and the configuration mode of the B2200.
2002	**Unsupported Module**
2003	**Unsupported Configuration**
2006	**Command not supported on this card** Command was used that is not supported by the card.
2009	**Too many channels in channel list** Too many channels are specified in the channel list (maximum 120).
2011	**Empty channel list** No channel list is specified.
2012	**Invalid channel range** Wrong channel list is defined. Confirm the syntax of the channel list, the card configuration, and the configuration mode of the B2200.

B2200 Card/Mode/Port Related Errors

Error Number	Error Message and Description
3000	**Card0 initialization fail** The B2200 may be defective. Contact your nearest Agilent Technologies service center.
3001	**Card1 initialization fail** The B2200 or card installed in slot 1 of the B2200 may be defective.
3002	**Card2 initialization fail** The B2200 or card installed in slot 2 of the B2200 may be defective.
3003	**Card3 initialization fail** The B2200 or card installed in slot 3 of the B2200 may be defective.
3004	**Card4 initialization fail** The B2200 or card installed in slot 4 of the B2200 may be defective.
3011	**Bad couple port number** For the *Input Port No.* for the couple port, only 1, 3, 5, 7, or 9 are allowed.
3012	**Bad bias port number** For *Input Port No.* for Bias Port, only 1 to 10 are allowed.
3013	**Cannot connect multiple channels in SROUTe mode** For the single connection rule, an input port can be connected to only one output port, and an output port can be connected to only one input port.
3014	**Cannot directly specify Bias Port channel** Relays on the input bias port cannot be controlled directly when the bias mode is ON.

Error Number	Error Message and Description
3017	**Too many relays closed. Max 52 relays/card.** Too many relays have been closed. To close new relays, open some relays. Maximum 52 relays can be closed for each module.
3018	**Can't change to ACONfig mode. Check card config.** The present card configuration of the B2200 does not allow the auto configuration mode. Change the module configuration.
3019	**Cannot use same port for Couple and Bias** The couple mode and the bias mode cannot be used in parallel when a couple port and the input bias port have been assigned to the same input port.
3020	**Bad auto ground port number** Specify the output ports effective for the input ground port. The port number must be 1 to 14
3021	**Bad unused port number** Specify the input ports effective for the ground enabled input port (unused port). The port number must be 1 to 9.
3022	**Cannot directly specify auto ground port channel** Relays on the input ground port cannot be controlled directly when the ground mode is ON.
3023	**Cannot directly specify unused port channel** Relays on the ground enabled input port (unused port) cannot be controlled directly when the ground mode is ON.
3024	**Cannot use same port for Couple and Auto Ground** The couple mode and the ground mode cannot be used in parallel when a couple port and the input ground port have been assigned to the same input port.
3025	**Cannot use same port for Unused and Auto Ground** The input ground port and the ground enabled input port (unused port) cannot be assigned to the same input port.

Error Number	Error Message and Description
3026	**Cannot use same port for Unused and Couple** The couple mode and the ground mode cannot be used in parallel when a couple port and the ground enabled input port (unused port) have been assigned to the same input port.
3027	**Cannot use Unused Port during Auto Ground Mode ON** The ground enabled input port (unused port) must be opened during the ground mode is ON.
3030	**Bad input port number** The input port number must be 1 to 14.
3031	**Bad output port number** The output port number must be 1 to 12, 24, 36, or 48. Maximum number depends on the switch module configuration.
3032	**Bad setting memory number** The internal memory number for the setup data must be 1 to 8.
3033	**EEPROM programming failure** Cannot change the GPIB address or update internal memory data. Contact your nearest Agilent Technologies service center.
3034	**EEPROM reading failure** Cannot read the GPIB address or internal memory data. Contact your nearest Agilent Technologies service center.
3035	**Setting memory data is invalid** Cannot read the setup data in the internal memory. The data has been broken. Delete the data.
3036	**Cannot load this setting data in this configuration** Cannot read the setup data in the internal memory due to the configuration mismatch. Delete the data or leave it until restoring the module configuration.